35 centavos a copy
₱4.00 a year
(10 numbers)

The Philippine Agriculturist

Foreign subscription
$2.50 a year
(U. S. currency)

Entered at the Post-Office at Los Baños, Laguna, as second-class mail-matter

EDITORS

Evett D. Hester, A. B.
Professor of Economics

Emma S. Yule, B.D.
Associate Professor of English

BUSINESS MANAGER
Nemesio B. Mendiola, Ph.D.
Associate Professor of Agronomy

ASSISTANT BUSINESS MANAGER
José M. Capinpin, B.Agr.
Assistant in Agronomy

BOARD OF CONTROL
Charles Fuller Baker, M. S.
Dean, College of Agriculture

Manuel L. Roxas, Ph.D.
Professor of Chemistry

Bienvenido Ma. Gonzalez, M.S.
Professor of Animal Husbandry

Otto A. Reinking, M. S.
Professor of Plant Pathology

Forman T. McLean, Ph.D.
Professor of Plant Physiology

VOL. IX JANUARY-FEBRUARY, 1921 No. 6-7

CITRUS DISEASES OF THE PHILIPPINES, SOUTHERN CHINA, INDO-CHINA, AND SIAM [1]

By OTTO A. REINKING

Professor of Plant Pathology
and Plant Pathologist of the Agricultural Experiment Station, Los Baños, Philippine Islands

FOURTEEN PLATES

The cultivation of citrus on a commercial basis in the Philippine Islands dates back to the early Spanish days. Today many of the species of citrus are found scattered throughout the Islands. The chief commercial center of the citrus industry is in the province of Batangas where there are orchards of mandarin oranges. Modern culture methods have never been used on a large scale. For the past twenty years the plantations have been badly neglected and diseases have become very prevalent. These troubles have been described and listed in papers on Philippine diseases of economic plants and control measures for most of the maladies suggested.[2] Since the publication of these papers further investigations of the causes and controls for various diseases have been made and more data secured.

A study of the diseases in Southern China, Indo-China, and Siam was made by the writer in collaboration with the division of Crop Physiology and Breeding Investigations of the Bureau of Plant Industry, Washington, D. C. The trip

[1] Experiment Station contribution No. 44.

[2] Reinking, Otto A., Philippine economic plant diseases. **Philippine Jour. Sci., Sec. A, 13**: 165-274 Pl. 1-22, fig. 1-43. 1918. *Idem*, Host index of diseases of economic plants in the Philippines. **The Philippine Agriculturist 8**: 38-54. 1919.

through Southern China was made during the months of May and June, 1919. The results of this investigation were published.[3] During May, June, and July of 1920, another trip, in collaboration with the division of Crop Physiology and Breeding Investigations, was made in Southern China, Indo-China, Siam, and the Federated Malay States. This trip gave an opportunity to make a careful study of citrus and its diseases in those countries. Although the season of the year in Indo-China and Siam was particularly dry, and the diseases were not in their most virulent form, it is believed that the most important fungi were present and found at that time.

The division of Crop Physiology and Breeding Investigations of the Bureau of Plant Industry under the direction of Mr. W. T. Swingle has established a tropical station for citrus fruits at the Agricultural Experiment Station of the College of Agriculture, at Los Baños, Laguna, Philippine Islands. The plantations contain an extensive collection of citrus from the United States and the Orient. Shipments of the most promising types from a disease-resistant standpoint are constantly made to the United States. The fungi and insects attacking plants in the Philippine Islands should be fully understood so that introductions of diseased plants into the United States may be avoided. Collections of citrus made in the East are assembled at the station for examination before shipping them to the United States. Consequently each year shipments of plants from the surrounding countries are made into the Islands. It is therefore of great importance to have a clear understanding of the diseases of citrus in the neighboring countries so as to exclude all dangerous pests.

The following pages present a discussion of citrus diseases found in the Philippines, Southern China, Indo-China, and Siam. The work is divided into six main sections, one for each region, one for control measures and a summary compiled on the basis of the hosts. A description of the diseases, a discussion of the causal organism, and suggestions regarding the control measures proper for each is given. As the diseases found in the other countries are primarily the same as those in the Philippines, it was deemed necessary to discuss them in detail only under the latter country. As a large number of fungi are parasitic on scales, a list of these collected in each country is given. The accounts of diseases found in the Philippine Islands and Southern China, published in 1918-19, were revised, and with corrections and additions are embodied in the present article.

THE PHILIPPINES

DISEASES

ALBINO. NON-PARASITIC

Occasionally a freak albino plant is found in a citrus planting. Such a tree is characterized by a yellowing or whitening of the leaves and stems. Frequently the leaves are not entirely whitened, but striped streaks extend down the branches. The trouble is of no economic importance. The albino character can be transmitted by vegetative propagation.

No organism is associated with the affection. Selection of stock from healthy citrus plants will entirely eliminate the trouble.

---

[3] Reinking, Otto A., Diseases of economic plants in Southern China. **The Philippine Agriculturist 8**: 109-135, Pl. 1-3 1919.

BARK ROT. *Diplodia*

Citrus trees growing in neglected and poorly kept orchards may be seriously attacked by an organism producing a bark rot. The disease may also be present in well-kept plantations, but usually is not so destructive. The first indication of the rot is a slightly raised, sometimes cracked portion, from which generally a drop of gum arises. Diseased areas gradually increase in size; gum in most cases oozes out in more abundance; and in the later stages a froth is present which indicates the presence of yeasts and other saprophytic organisms. The older cracked and rotted parts may be one-half to five centimeters wide and from three to ten or fifteen centimeters long, extending lengthwise with the trunk. In the older cases the bark gradually sloughs off leaving irregular rotted patches that extend through to the wood (Plate I). The margins of the affected parts are usually made up of healthy growing tissue, which, if treated, will in time grow over and fill in the injury.

Internal symptoms of new cases of rot are characterized by a slight, brownish, watery discoloration of the tissue just above the cambium layer. Below the rotted area there is frequently produced a green coloration which appears to be due to an abnormal production of chlorophyll. Older rotted areas may also show this green, but the diseased parts are generally more or less brown and are usually covered with a watery froth formed by secondary factors such as yeasts and insects that have gained entrance into the weakened tissues. A disagreeable odor is present in such advanced cases. It is believed that the fungus gains entrance through injuries in weakened trees, as healthy vigorous growing trees are not so subject to the attack.

Isolations from the diseased portions yield in all cases a species of *Diplodia*. Table I gives a list of isolations made from various species of citrus and shows that the same fungus is associated with the disease throughout the year.

TABLE I.—*Isolations.*

Date.	Host.	Organism isolated.
Dec. 14, 1918.....	*Citrus nobilis* from Batangas.....	*Diplodia*
Dec. 14, 1918.....	*Citrus nobilis* from Batangas.....	*Diplodia*
Dec. 14, 1918.....	*Citrus nobilis* from Batangas.....	*Diplodia*
Dec. 14, 1918.....	*Citrus nobilis* from Batangas.....	*Diplodia*
Dec. 14, 1918.....	*Citrus nobilis* from Batangas.....	*Diplodia*
Jan. 21, 1920.....	*Citrus nobilis* from Batangas.....	*Diplodia*
Jan. 21, 1920.....	*Citrus nobilis* from Batangas.....	*Diplodia*
Jan. 21, 1920.....	*Citrus nobilis* from Batangas.....	*Diplodia*
Jan. 21, 1920.....	*Citrus nobilis* from Batangas.....	*Diplodia*
May 19, 1920.....	*Citrus nobilis*.....	*Diplodia*
June 21, 1920.....	*Citrus* sp.....	*Diplodia*

The organism producing the disease is found on practically all citrus species and attacks the citrus relatives as well. Bark rot has been observed on the following *Citrus: Citrus nobilis* Lour. var. *deliciosa* Swingle (mandarin orange), *Citrus maxima* (Burm.) Merr., (*Citrus grandis* Osbeck) (pummelo), *Citrus*

medica Linn. (citron), *Citrus limonia* Osbeck (lemon), *Citrus aurantifolia* (Christm.) Swingle (lime), *Citrus aurantium* Linn. (sour or Seville Orange), *Citrus sinensis* Osbeck (common or sweet orange), *Citrus hystrix* DC. (native lime), and *Citrus mitis* Blanco (calamondin orange). *Citrus medica* Linn. (citron), and *Citrus nobilis* Lour. var. *deliciosa* Swingle (mandarin orange) appear to be most severely attacked. As the disease is found on practically all species, it does not seem as if a highly resistant variety can be selected. *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck) (pummelo,) and *Citrus mitis* Blanco (calamondin orange) are less subject to the attack and show some resistance.

A large series of inoculation experiments were undertaken on various species of citrus. The inoculations were made after cleaning the branches or trunk carefully with water, then disinfecting with mercuric chloride, and finally washing with sterilized water. Incisions were made in the bark with a sterilized scalpel and portions of the mycelium or spores of a pure culture of the fungus were introduced. The inoculated portions were either left without a protective covering or covered with waxed paper and kept moist with cotton. Infection always took place in either case, but it was usually more severe when waxed paper and moist cotton were applied. In all cases a culture isolated from bark rot of *Citrus nobilis* Lour. var. *deliciosa* Swingle (mandarin orange) was used for inoculations. Table II gives a list of these inoculations and the results.

As shown in Table II, a variety of species of citrus can be successfully inoculated with the *Diplodia* isolated from a case of bark rot of mandarin orange. Re-isolations in all cases resulted in the finding of the same fungus used for inoculations. The controls, in all instances, remained healthy without gumming and rotting, and the wounds healed over rapidly (Plate II, fig. 4). The first symptoms of infection on the inoculated seedlings, after from two to five days, was a browning or blackening about the region of the injury. This was followed by an excessive gumming and the advance of the fungus into the healthy tissue (Plate II, fig. 3). Often cracks appeared in the bark one to two centimeters from the point of insertion, indicating the fungus advance (Plate II, figs. 2 and 6). In the course of two weeks a definite rotted area, frequently six centimeters long and three centimeters wide, was produced. This rotted area had the general character of the young cases of natural infection (Plate II, figs. 1 and 5). The bark of the diseased parts was easily removed, leaving the characteristic irregular rotted patches that extend through to the wood. Minute black specks, which were the pycnidia, developed in some cases in abundance on the dead bark and at times in the bark on the edges of the diseased tissue. The margins of the affected parts were lined with healthy, newly developing bark tissue (Plate II, figs. 1 and 5). On vigorous growing trees the wounded and infected portions gradually healed.

Inoculations carried on by Reyes,[4] with the fungus isolated by the writer from the bark rot of Batangas mandarin, also proved conclusively that the disease could be produced by the *Diplodia*. Reyes also showed that the same fungus would produce the typical dry sooty rot of citrus and other fruits.

Reyes, Gaudencio M., Storage-rots caused by Diplodia. **The Philippine Agriculturist 8**: 235-260, 1920.

TABLE II.—*Inoculation experiments.*

Date of inoculation.	Host inoculated through injury.	Character of disease produced.
Mar. 12, 1919	*Citrus* sp.	Excessive gumming, slight rot.
Mar. 12, 1919	*Citrus* sp.	Excessive gumming, slight rot.
Mar. 12, 1919	*Citrus* sp.	Excessive gumming, slight rot.
Mar. 12, 1919	*Citrus* sp.	Excessive gumming, severe rot, ½ inch.
Dec. 26, 1919	*Citrus maxima*	Excessive gumming, slight rot.
Dec. 26, 1919	*Citrus limonia* (rough lemon)	Excessive gumming, slight rot.
Dec. 26, 1919	*Citrus sinensis*	Excessive gumming, slight rot.
Dec. 26, 1919	*Citrus mitis*	Excessive gumming, slight rot.
Dec. 26, 1919	*Citrus hystrix*	Excessive gumming, slight rot.
Dec. 26, 1919	*Citrus limonia* (Kusaei lime)	Excessive gumming, slight rot.
Dec. 26, 1919	*Citrus medica*	Excessive gumming, slight rot.
Dec. 26, 1919	*Citrus nobilis*	Excessive gumming, slight rot.
Dec. 26, 1919	*Citrus limonia* (Lisbon lemon)	Excessive gumming, slight rot.
Dec. 26, 1919	*Citrus* sp. (Bujao)	Excessive gumming, slight rot.
Jan. 21, 1920	*Citrus medica*	Gumming and rotting of bark.
Jan. 26, 1920	*Citrus medica*	Gumming and rotting of bark.[a]
Jan. 26, 1920	*Citrus maxima*	Gumming and rotting of bark.
Jan. 28, 1920	*Citrus maxima*	Gumming and rotting of bark.
Jan. 28, 1920	*Citrus medica*	Gumming and rotting of bark.
Jan. 28, 1920	*Citrus medica*	Gumming and rotting of bark.[a]
Jan. 29, 1920	*Citrus* sp.	Gumming and rotting of bark.
Jan. 29, 1920	*Citrus limonia*	Gumming and rotting of bark.
Jan. 29, 1920	*Citrus maxima*	Gumming and rotting of bark.[a]
Jan. 30, 1920	*Citrus medica*	Gumming and rotting of bark.
Jan. 30, 1920	*Citrus medica*	Gumming and rotting of bark.
Jan. 30, 1920	*Citrus medica*	Gumming and rotting of bark.
Feb. 9, 1920	*Citrus maxima*	Gumming and rotting of bark.
Feb. 10, 1920	*Citrus mitis*	Gumming and rotting of bark.
Apr. 4, 1920	*Citrus* sp.	Excessive gumming, slight rot,[a] recovered.
Apr. 4, 1920	*Citrus* sp.	Excessive gumming, slight rot,[a] recovered.
Apr. 19, 1920	*Citrus* sp. (2 plants)	Excessive gumming, slight rot,[a] recovered.
Apr. 19, 1920	*Citrus* sp. (3 plants)	Excessive gumming, severe rot.
July 2, 1920	*Citrus aurantium* (10 plants)	Excessive gumming, pycnidia.

[a]Rotting confined to wounded tissue.

Sufficient evidence, such as the constant isolation of *Diplodia* from field cases of the rot, and the large number of successful inoculations carried out, in which typical bark rot was produced, has been obtained to assign a definite causal organism (*Diplodia*), as the factor concerned in the production of citrus bark rot.

The mycelium of the fungus is produced in abundance in pure culture and is hyaline when young and dark brown when old (Plate III, fig. 1). It is granular, septate, and very much branched. Pycnidia are produced in groups in pure culture, especially on corn meal and on rotted fruits. They are not produced in such large numbers on the rotted bark of citrus trees. The pycnidia are at first under the epidermis, but later rupture it. They are membraneous, of various sizes and shapes, but usually when mature are subglobose and pappilate. They measure (inside measurement) from 51 microns to 119 microns in diameter. Paraphyses, conidiophores, and conidia are produced within the pycnidia.

The conidia are elliptical, hyaline, granular, and nonseptate when young, but dark brown, and uniseptate when mature. Striated longitudinal bands are produced on the exospore. They germinate readily in water by the production of usually one, but sometimes two germ tubes. The spores vary in size. Measurements taken of conidia growing in pure culture show a variation of from 12 to16 microns in width and 22.4 to 27.2 microns in length. The average size is from 13.5 to 14.5 microns wide by 24.5 to 25 microns long.

The causal organism isolated from the bark rot of citrus and used for inoculations is of the species *Diplodia*. Cross inoculations carried out by Reyes [4], under the writer's directions, proved that the organism would produce a rot of sweet potatoes, cacao pods, mulberry cuttings, citrus trees (mandarin), patani pods (green), cassava cuttings, papaya petioles, and citron fruits (Plate III, fig. 2). This would indicate that the *Diplodia* causing the rot of each of these fruits under natural conditions is similar to the one causing the bark rot of citrus.

According to Taubenhaus, [5] the members of the Sphaeropsideae producing brown uniseptate spores are extremely variable and the distinction between the various genera is slight. Consequently the generic name *Diplodia* has been used to designate the organism causing the bark rot and gummosis of citrus in the Philippine Islands. The determination of the species has been left until a future date because the cross inoculations carried on by Reyes indicate that the majority of the species isolated from various hosts are similar.

The fungus growing on dead branches and leaves of citrus in the Philippine Islands has been determined by Saccardo as *Diplodia aurantii* Catt. The *Diplodia* isolated from citrus bark rot does not conform to the description of this species. Other species of *Diplodia* found on citrus in various parts of the world are *Diplodia citricola* McAlpine, in Australia on lemon twigs, stems, and green fruits; *Diplodia destruens* McAlpine, in Australia, on orange and lemon leaves; *Diplodia hesperidica* Speg., in Argentina, on fallen leaves and branches of *Citrus aurantium* Linn.; *Diplodia heteroclita* Dur. et Mont., in Algeria, on *Citrus aurantium* Linn; and *Diplodia natalensis* Pole Evans, in Union of South Africa, on citrus fruit.

The fungus isolated from bark rot in the Philippines resembles most closely that of *Diplodia natalensis* Pole Evans. It is believed that the *Diplodia* found

[5] Taubenhaus, J. J. The probable non-validity of the genera Botryodiplodia, Diplodiella, Chaetodiplodia and Lasiodiplodia. **American Journal of Botany 2**: 324-331. 1915.

on and causing the rot of citrus and that found on various other fruits is the same species. Reyes found that the behavior of various so-called forms of *Diplodia* in pure culture was very much alike, and the similarity of spores produced was marked. The ability to cross-inoculate these various forms of *Diplodia* isolated from many sources would indicate also that many of these were identical (Plate IV).

It has been observed that trees growing under well-cultivated conditions are less apt to be attacked than those growing in neglected orchards. Experiments carried out on the control of bark rot and gummosis at the College of Agriculture show that clean cultivation and the production of healthy, vigorous growing trees will reduce the amount of infection. Spraying experiments with Bordeaux mixture and Burgundy mixture showed that the trees sprayed were not markedly attacked, while those unsprayed were more likely to be diseased. The most satisfactory control in severely infected orchards consists in the collection and destruction of all dead branches, and the destruction of fruits diseased with black rot. All bark rotted and gummosis areas should be cut out down to healthy wood, and the wounds painted with Bordeaux paste. The results obtained were satisfactory as regards the use of sanitation, removal of diseased parts, and painting with Bordeaux paste. The paste is applied best with a brush. In heavily infected orchards the entire trunk and older branches should be kept covered with a coating of the mixture. Constant observations must be made in order to detect and remove new cases of disease. Lime-sulphur paste may also be used with success in place of the Bordeaux paste. Painting the cut-out sections with crude carbolic acid wash, made of one half crude carbolic acid and one half water, is also effective.

BLIGHT OF SEEDLING. *Phytophthora*

Seedlings and newly developed shoots from the buds of budded plants may be seriously attacked and frequently killed by a *Phytophthora* blight producing fungus (Plate V, figs. 2 and 3). The trouble is most severe during damp weather. The young tender tip is first infected. The disease advances until the entire shoot or seedling is killed. Blighted plants are characterized first by the death and blackening of shoot-tips and leaves. The fungus then advances producing a brown watery infection of the tender parts. The progress usually ceases when the older wood is reached. The disease has been observed on the following fruit tree seedlings: avocado (*Persea americana* Mill.), guava (*Psidium guava* Linn.), hevea rubber (*Hevea brasiliensis* (HBK) Muell.-Arg., mango (*Mangifera indica* Linn.), and roselle (*Hibiscus sabdariffa* Linn.)

Isolations made from affected parts, in all cases, yielded a *Phytophthora*. This fungus when inoculated into healthy plants produces the typical infection (Plate V, fig. 1). It resembles somewhat the fungus that produces coconut bud rot, black rot of cacao, and the rots of various other plants.

All diseased parts should be removed by cutting well back into the healthy tissue; the cut-out parts should be burned. Damp conditions and dense shade should be avoided, as the disease is most severe under such conditions. Clean culture in nurseries is advised so as to allow plenty of air movement. Spraying with Bordeaux mixture will effectively prevent infection.

CANKER. *Pseudomonas citri* HASSE

Citrus canker is widely spread in the Philippine Islands. The disease occurs in practically all parts of the Islands where citrus trees are grown, from the mountain provinces in northern Luzon, south through the central islands, down to Mindanao. It is highly infectious and destructive to most citrus varieties, but a difference in degree of susceptibility is shown. On the commonly planted citrus fruit, *Citrus nobilis* Lour. (Canton mandarin), the disease is only slightly prevalent and does little damage. The other extreme in sensitiveness is exhibited by *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck) (grape fruit and pummelo), the young plants of which are severely attacked and sometimes killed. The infection on older trees, as exhibited by the native pummelo varieties grown in the Philippine Islands, causes little damage, although the fruit is defaced.

The general degree of susceptibility of citrus trees in the East is indicated in the following list; the species named first being the most severely attacked: *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck) (large pummelo, bitter pummelo, Indian pummelo, Siamese pummelo, grape fruit, djersek boli), *Citrus aurantifolia* (Christm.) Swingle (lime), *Citrus aurantium* Linn. (sour or Seville orange), *Citrus limonia* Osbeck (lemon), *Citrus hystrix* DC. (native wild lime), *Citrus sinensis* Osbeck (common or sweet orange), *Citrus medica* Linn. (citron), *Citrus medica* Linn. var. *sacrodactylis* Swingle (fingered citron), *Citrus hystrix* DC. var. (native wild lime), *Citrus nobilis* Lour. (king orange), *Citrus nobilis* Lour. var. *unshiu* Swingle (Satsuma or Unshiu orange), *Citrus nobilis* Lour. var. *deliciosa* Swingle (mandarin orange), and *Citrus mitis* Blanco (calamondin orange).

A great variation may occur in the degree of infection of different varieties in the same species. The general order of severity of attack, however, is as indicated in the above list. Young plants are more severely attacked than older plants.

A knowledge of the susceptibility to attack is of utmost importance in the production of disease resistant plants by hybridization. A study made of the hybrids under test at the College of Agriculture at Los Baños clearly shows that those with pummelo, (*Citrus maxima* (Burm.) Merr.), characters are extremely susceptible to canker infection. Out of 655 hybrids with pummelo characters, 411, or 63 per cent were severely infected; 123, or 19 per cent, had medium infection; 42, or 6 per cent, had slight infection, and 79, or 12 per cent, had no infection. A study of the conditions under which those that had no infection were growing showed that a number of these plants had not been exposed. Also, those not infected were crosses with either mandarin, tangerine, or sour orange, all of which are less subject to infection than the pummelo. Of the 79 plants not infected, 12, or 16 per cent, were mandarin and pummelo crosses; and 11, or 14 per cent, were sour orange and pummelo crosses; and 8, or 10 per cent, were tangerine and pummelo crosses. While the majority of the mandarin, tangerine, and sour orange with pummelo crosses in the entire plantings were commonly severely affected with canker, it may still be that a few are resistant because the mandarin, tangerine, and sour orange are not under natural conditions badly infected. In order to prove actual resistance to canker on pummelo hybrids, careful exposure tests will have to be made before any real resistance can be proved. The use of the mandarin

or calamondin orange as one parent of the cross will probably give the best results in so far as susceptibility to canker is concerned. Crosses with citrus relatives should also show some good results.

A large number of citrus relatives growing on the College of Agriculture farm at Los Baños show resistance to canker under field conditions. A number of these can be inoculated with the organism and the disease produced. Those that appear to be resistant to citrus canker under plantation conditions are the following: *Aegle marmelos* Correa, *Aeglopsis*, *Aeglopsis chevalieri* Swingle, *Balsamocitrus gabonensis* Swingle, *Balsamocitrus paniculata* Swingle, *Severinia buxifolia* Ten., and *Xanthoxylum avicenae* Linn. The following species are infected to a more or less degree upon inoculation with the organism: *Atalantia*, *Atalantia citrioides* Pierre, *Balsamocitrus dawei* Stapf., *Chaetospermum glutinosa* (Merr.) Swingle, *Chalcas*, *Chalcas exotica* Millsp., *Citropsis schweinfurthii* Swingle and M. Kellermann., *Claucena lansium* Skeels., *Eremocitrus glauca* (Lindl.) Swingle, *Feronia limonia* (Corr.) Swingle, *Feroniella lucida* Swingle, *Fortunella hindsii* (Oliver) Swingle, *Fortunella japonica* Swingle, *Fortunella margarita* (Lour.) Swingle, *Hesperethusa crenulata* Roem., *Microcitrus australasica* (Muell.) Swingle, *Microcitrus garrowayi* (Bail.) Swingle, *Paramignya monophylla* Wight, *Toddalia asiatica* (Linn.) Kurz., and *Triphasia trifolia* P. Wilson.

Atalantia, *Atalantia citrioides* Pierre, *Citropsis schweinfurthii* Swingle and M. Kellermann, and *Triphasia trifolia* P. Wilson are resistant in the field even though subject to the organism. From the investigation carried on at the College of Agriculture, it seems highly probable that a number of species listed as resistant under field conditions would contract the disease under proper conditions of inoculation. *Triphasia trifolia* P. Wilson while reported immune can be infected through needle pricks, although under field conditions it is resistant.

The characteristic canker formation may be produced on leaves, stems, and fruit. At first the spots on leaves are small, round, watery, slightly raised dots. These dots enlarge, turn brown, extend through the leaf, rupture, and become raised on one or both surfaces. Concentric, irregular rings may be produced in the brown center. Frequently spots run together forming an elevated, elongated, ruptured, brownish blotch (Plate VI, fig. 2). In seedlings, severe defoliation may take place resulting in death of the plant. Frequently a leaf-mining insect carries the infection through its winding gallery or mine, in the form of a chain of canker spots (Plate VI, fig. 3). This miner is the larva of a small moth, *Phyllocnistis citrella* Stainton, and is common throughout the Orient, being especially injurious to nursery stock.

On the twigs the spots are somewhat different. At first they are similar to those on the leaf, but later become irregular, raised, spongy, brown spots, often with a dark brown border. The spots are cankerous and persistent, but are only formed in the outer layers of the bark tissue. Frequently twigs are entirely encircled by cankers, but do not seem to be killed outright in all cases (Plate VII, figs. 1 and 2).

The first stages of the disease on the fruit are similar to those on the leaf. Affected areas may be scattered, but frequently they run together, forming irregular, raised, brown cankerous blotches. The surface of the fruit is depressed or slightly wrinkled in the neighborhood of large infections (Plate VII, figs. 2, and 3). Cankers do not penetrate deeply below the surface, and seem to do little

harm, except in severe cases of infection, other than producing an unsightly appearance. Gumming of the fruit is associated with the disease in some cases, but this is not general.

The disease is far more prevalent during the rainy season than during the dry. In the dry season the spread is practically negligible. After heavy wind and rain in the wet season, the malady is extremely serious.

The bacteria causing the disease gain entrance to the host through injuries and through the stomata. Inoculations carried out at the College of Agriculture showed that infection readily took place through needle punctures and that between 40 and 50 per cent infection could be obtained through the stomata of apparently uninjured leaves (Plate VIII, figs. 2, 3, and 4). The infection under field conditions is usually more severe on those susceptible species that are highly spiny, due to injury caused by the whipping of the leaves against the spines (Plate VIII, fig. 1). The organism appears to be spread throughout the tree primarily by rain. The bacteria grow readily in pure culture, producing yellow pigmented colonies.

The control of citrus canker is rather difficult, but the disease can be reduced to a minimum by spraying and pruning. In the Philippine Islands, the mandarin orange, (*Citrus nobilis* Lour.), is the most commonly cultivated species and since it is relatively free from disease no control measure need be applied. The selection of other resistant varieties is being undertaken at the College of Agriculture. Many species, however, are severely infected especially when young. For these, control measures should be practiced. Persistent effort is necessary to obtain an effective control. This is true in the case of the majority of bacterial diseases of fruit trees. Experiments undertaken at the College of Agriculture during the past two years show that a combination control of spraying and pruning of the diseased portions will produce beneficial results.

The spray mixtures used in these experiments were Bordeaux mixture, copper sulphate, 1.8 kilograms, stone lime 1.8 kilograms, and water 190 liters; and Burgundy mixture, copper sulphate 1.4 kilograms; sodium carbonate 1.65 kilograms, water 190 liters. A resin sal soda sticker, prepared with resin 0.9 kilograms, sal soda 0.45 kilograms, and water 3.8 liters, was added to the spray mixtures to increase their adhering qualities. Due to the fact that the fungi parasitic on scale insects were killed by these fungicides, and that the scales became a menace, it was found necessary to apply a kerosene emulsion spray from time to time. It probably would be preferable to apply a lime-sulphur spray in place of a copper spray, since the lime-sulphur acts both as a fungicide and an insecticide. The sprays were applied with a pressure spray pump, and the applications were made as indicated in Table III. Before the spraying operations were started, the average percentage of infection on the various varieties was determined. Other sets of percentages were struck while the spraying was in progress. All severe cases of stem and fruit infection were removed by pruning during the test. The experiments were carried out on bearing trees.

The August observations were made a week before spraying began so that infections were normal for every variety. The spraying showed no material effect after two months because the old infections observed at the beginning of the experiments were still on the trees and counted. Infections on newly developed leaves were reduced. Pruning was done in February 1919 in all lots. The April

TABLE III.—*Sprays and results with degree of infection given according to months of observation.*

SPECIES.	Degree of Infection of control.	BORDEAUX MIXTURE.							BURGUNDY MIXTURE.						
		Aug.	Nov.	Jan.	April	June	Aug.	Oct.	Aug.	Nov.	Jan.	April	June	Aug.	Oct.
Citrus mitis (Calamondin)	Slight	Sl.	Sl.	Sl.	None	None	None	None	Sl.	Sl.	Sl.	None	None	None	None
Citrus nobilis (Canton Mandarin)	Slight	Sl.	Sl.	Sl.	None	None	None	None	Sl.	Sl.	Sl.	None	None	None	None
Citrus hystrix (Wild lime)	Slight	Sl.	Sl.	Sl.	None	None	None	None	Sl.	Sl.	Sl.	None	None	None	None
Citrus medica (Citron)	Slight	Sl.	Sl.	Sl.	None	None	None	None	Sl.	Sl.	Sl.	None	None	None	None
Citrus sinensis (Small orange)	Slight	Sl.	Sl.	Med.	None	None	None	None	Sl.	Sl.	Med.	None	None	Sl.	None
Citrus sp. (Colobot)	Medium	Med.	Med.	Med.	None	None	None	None	Med.	Med.	Med.	Sl.	None	Sl.	None
Citrus sinensis (Large sweet orange)	Medium	Med.	Med.	Sl.	Sl.	None	None	None	Med.	Med.	Sl.	Sl.	None	Sl.	None
Citrus limonia (Rough lemon)	Medium	Med.	Med.	Sl.	None	None	None	None	Med.	Med.	Sl.	None	None	Sl.	None
Citrus aurantifolia (Kusaie lime)	Medium	Med.	Med.	Sl.	None	None	None	None	Med.	Med.	Sl.	None	None	Sl.	None
Citrus maxima (All types)	Severe	Sev.	Med.	Sl.	Sl.	None	Sl.	Sl.	Sev.	Med.	Sl.	Sl.	None	Sl.	Sl.

observations showed a decrease in the canker present. This was partially due to the spray, the pruning, and also to the dry season during which the canker infection is normally low. Between the end of July and August 14, heavy rains and winds occurred causing much injury to leaves and twigs. As a result infection was increased except on the lot sprayed just at the close of the rainy weather with the Bordeaux mixture. The Burgundy spray mixture was applied one week after the bad weather and some of the trees showed a slight infection. The sprays should be applied immediately after storms so as to prevent new infections. The October observations showed little or no canker produced on the sprayed trees. The appearances of the canker affections on sprayed trees are entirely different from those on the control trees. The canker organism appears to be weakened due to the presence of the copper, and the infections produced are small, rather dried out, and dark brown. The spread of the organism from these parts is practically negligible. The canker affection was never entirely eliminated on the pummelo trees, *Citrus maxima* (Burm.) Merr.

The expense of application under Philippine conditions during the months of the experiment showed that the spraying could be carried out on a commercial basis although the cost was rather high. Spraying with Bordeaux mixture cost 60 centavos a tree for one year's application of 12 sprayings or 5 centavos a tree for each spraying. Spraying with Burgundy mixture over the same period cost approximately 80 centavos a tree, which is more expensive than the Bordeaux mixture application and the results were no better. Burgundy mixture should be substituted only when limestone is not obtainable.

The experiment would indicate that spraying once each month, on old trees, is not necessary, as during the dry season the canker is not severe. Spraying should be done at least once each month during the rainy season, taking special care that the trees are always well covered after each heavy storm. This would reduce the spraying down to at least six sprays a year and lower the cost to 30 centavos a tree for the entire year's spraying. As the infection takes place on new growth, the removal of old cankered areas by pruning is highly desirable. It is practically impossible to keep the new growth covered with the spray, but by reducing the sources of infection, by pruning and spraying, the disease can be held at a minimum.

Since the canker is not severe on the bearing trees of the majority of commercial varieties, such as the loose skinned orange, grown in the Philippines, it is not necessary to spray these older trees. Young trees in the nursery, however, may be severely attacked, and it is highly desirable to spray these at least once each month during the rainy season. If Bordeaux mixture is used, kerosene emulsion must be applied also from time to time as required, in order to combat aphids and scale insects.

CHLOROSIS. NON-PARASITIC

Frequently leaves on certain trees show a general yellowing in contrast with the definite coloring as produced in mottled leaf. All the leaves of the trees are uniformly yellowed or the coloration may be confined to individual leaves. In some cases this change covers the entire leaf, while in others only large blotches are produced. A uniform discoloration of the leaves seems to be due to malnutrition, probably a lack of nitrogen. When in blotches it may be due to the attacks of mites or other sucking insects.

No organism has been associated with the malady. Trees affected with foot-rot or general malnutrition become chlorotic.

The disease can be avoided by using healthy stock and by the practice of proper culture methods. Insect attacks must be controlled by entomological methods.

DAMPING OFF. *Rhizoctonia*

Seedlings grown in unsterilized soil and in poorly aerated places may be severely attacked just at the ground surface by a fungus, which first causes a browning of the stem and later a shrinking and weakening of the tissue. Severely diseased plants fall over and die. The disease is somewhat similar to, but more prevalent, than that produced by a *Sclerotium*.

The organism is a common soil fungus causing a large amount of destruction to tender plants during periods favorable to its spread. It grows well in pure culture first producing a coarse white mass of mycelium, which later turns brownish and produces a large number of brown sclerotial bodies. No spores have been observed. The fungus penetrates the plant tissues and causes the weakening and death of the cells.

Seedlings should be grown in sterilized soil and should be placed where there is sufficient sunlight and air movement.

DAMPING OFF. *Sclerotium*

Seedlings growing in damp and poorly aerated places are frequently attacked by a fungus that causes a rot which results in damping off. The stem is attacked near the ground and becomes brown, shrunken, and weak, due to cell destruction. Plants in the latter stages of the disease fall over and die.

Isolation and inoculation experiments demonstrate the disease to be due to a fungus that produces sclerotia. The fungus invades the tissues from the ground. Upon death of the plant, small, round, smooth, brown, sclerotial bodies are produced. These bodies germinate directly by the production of mycelium. No spores have been observed. The same fungus may cause a damping off of coffee seedlings, cacao seedlings, and other plants. In pure culture a dense white growth is first produced, which later gives rise to a large number of the sclerotial bodies.

The disease is easily controlled by growing plants in well-aerated places, free from too great humidity. If the soil is heavily infected with the fungus, soil sterilization should be practiced.

DIE-BACK

Die-back is common in poorly kept orchards and appears to be due mainly to a lack of nutrition. The symptoms are a gradual dying back of the branches, starting from the tip.

No definite causal organism has been assigned. Many fungi have been found on dead and dying twigs. On twigs of *Citrus nobilis* Lour. have been found: *Crinipellis galeatus* (Berk. et Curt.) Pat., *Cytospora aberrans* Sacc., *Diaporthe citrincola* Rehm., *Diplodia aurantii* Catt., *Eutypella citricola* Speg., *Hypoxylon atropurpureum* Fr., *Massarina raimundoi* Rehm., *Microcera coccophila* Desm.(On coccids), *Myriangium duriaei* Mont. (On coccids), *Polyporus hirsutus* Fr., *Rhytidopeziza rufula* (Spreng.) Bres., *Tryblidiella mindanaensis* P. Henn., *Tryblidiella rufula* (Spreng.) Sacc., *Valsaria citri* Rehm., *Xylaria castorea* Berk., and *Zignoella nobilis* Rehm. *Traversoa dothiorelloides* Sacc. et Syd. may be found on the bark.

On dead branches of *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck) have been observed: *Aschersonia sclerotioides* P. Henn. (On coccids), *Auricularia polytricha* (Mont.) Sacc., *Daldinia concentrica* (Bolt.) Ces. et de Not., *Duportella tristiuscula* (Berk.) Pat., *Eutypa heteracantha* Sacc., *Eutypella citricola* Speg., and *Polyporus rickii* Pat., var. *philippinensis* Pat. *Nectria episphaeria* (Tode.) Fr. has been observed growing on *Eutypella citricola* Speg. On dead wood of *Citrus* spp. may be found *Cyathus montagnei* Tul., *Duportella tristiuscula* (Berk.) Pat., *Fomes applanatus* Pers., *Ganoderma australe* (Fr.) Pat., *Heterochaete tenuicula* (Lév.) Pat., *Nummularia citrincola* Rehm., *Ozonium auricornum* Lk., *Polyporus caryophylli* Racib., *Polyporus hirsutus* Fr., *Rhytidopeziza rufula* (Spreng.) Bres., and *Schizophyllum commune* Fr.

Citrus culture in the Philippines is practiced in a haphazard manner. Dieback may be largely avoided by the use of correct culture methods. All dead and dying branches should be pruned out and burned.

EPIPHYTE. PARASITIC. *Loranthus philippensis* CHAMISSO ET SCHLECHT

One of the most serious parasitic troubles of the mandarin oranges, *Citrus nobilis* Lour., in the province of Batangas is due to the *Loranthus* which is found on neglected trees. The parasitic plant may spread over and completely replace the citrus. Birds visiting citrus trees covered with the epiphyte, eat the seeds and later may deposit them on other orange trees. The seeds germinate by producing a stem with haustoria that penetrate the host tissue. The established plant then develops as a vine and spreads over the entire tree producing the root-like structures every few centimeters (Plate IX, fig 1). In badly infected trees no leaves of citrus can be found, only leaves and flowers of the *Loranthus* are present. The spread of the epiphyte through neglected orchards is surprisingly rapid.

The *Loranthus* is a parasitic epiphyte deriving its support and nourishment, except that produced from its own leaves, from the citrus to which it is attached. Longitudinal sections through the parasite and host show the development of a series of haustoria (Plate IX, fig. 1). They penetrate the tissue to a depth of a few millimeters, in young branches, and to a depth of from one to two centimeters in older parts. In some cases they spread almost completely through the twig and usually widen and spread out along with the axis of the branch. The *Loranthus* can be easily distinguished from the citrus wood, when cut longitudinally, because of its darker color.

The citrus orchard should never be neglected so as to allow the *Loranthus* to obtain a hold. In affected plantations all parts of the parasite should be cut out. If it is thoroughly established and replaces the upper parts of the citrus, all the top branches of the tree down to those that are free from the epiphyte should be removed. The host plant will then produce new shoots and soon develop into a healthy tree. Care should be taken to remove the epiphyte if it re-appears.

FOOT ROT. UNDETERMINED

The trunk of the tree is attacked at, and just below, the surface of the ground. The first indication of the disease is usually a yellowish or chlorotic condition of the leaves and a gumming of the lower trunk. The affected bark then decays and gradually sloughs off, leaving a rotted patch. If the disease is not attended to, the trunk is girdled and the tree dies.

No study has been made of the disease to ascertain whether or not a definite organism is responsible. In many cases an organism undoubtedly is a factor in disease production. Trees grown in poorly drained locations are more subject to the malady. Citrus budded on sweet orange stock appears to be most severely affected.

The rotted bark should be cut out, well down to the healthy wood, from the infected parts on the trunk and roots. In order to accomplish this the soil must be first removed from crown and roots. All bark removed should be burned. The treated parts should be painted over with Bordeaux paste, and these portions should be left exposed to the light and air until recovery has taken place. Drainage should be provided if necessary.

FRUIT ROT. BLACK MOLD. *Mucor* SPECIES

Several species of *Mucor* may gain entrance through injured portions of fruits and cause a rot. The rotting is characterized by a black mold, composed of the fruiting bodies of the fungi, which are produced over the affected areas.

Great care should be taken in picking and storing fruits in order to avoid injuries, as the fungi gain entrance through bruised parts.

FRUIT ROT. *Diplodia*

A dry sooty rot of citrus fruit may take place and is due to the attacks of the common *Diplodia* dry rot organism. Diseased fruits are characterized by a shriveled, dry appearance, and are covered with a dense black sooty mass of spores (Plate III, fig. 2). The fungus is the same that causes bark rot and gummosis.

It gains entrance into the fruit through an injury. In advanced stages, a series of pycnidia are produced just under the surface of the fruit, and from there, through openings extending to the surface, the spores are expelled in large numbers. The spores when immature are single-celled, hyaline, very much granular, oval bodies. Upon reaching maturity, they become two-celled and dark brown. Germination takes place readily within a few hours in water. The spores may germinate before reaching the two-celled stage. The fungus grows well in pure culture, producing, on potato agar, a heavy growth of dark greenish to black mycelium. Spores are produced abundantly in corn meal cultures.

Care must be used in handling the fruit so as to keep it free from injuries. All rotted fruit should be burned.

FRUIT ROT. *Penicillium*

Fruit rots are present on fruit kept for some time out of storage. The *Penicillium* rot is characterized by the production of a green powdery mass of spores over the soft rotted area. The rot starts in some injury and gradually spreads until the entire fruit is infected.

The fungus penetrates the tissue of the fruit, causing a soft rot. On the surface of the fruit is produced an abundance of typical *Penicillium* spores which blow from diseased to healthy fruit, thereby causing infection.

The fruit must be kept free from injuries. It should be used as soon as possible, and if stored it is advisable to keep it in a well-aerated place so as to avoid excessive moisture.

Phyllosticta circumsepta Sacc. has been found on the dying rind of fruit.

GREASY SPOT. NON-PARASITIC

Blackish, greasy spots may be produced on both surfaces of the leaf. Affected parts are thickened, raised from the leaf surface, circular, but often run together forming blotches. In size, they vary from minute black specks to spots one centimeter in diameter.

Microscopic examinations and cultural studies have failed to show the presence of any fungus or bacterium. The disease does not appear to be infectious.

GUMMOSIS. *Diplodia*

Gummosis and bark rot are frequently stages of the same disease. A gumming of the trunk, stem, and fruit occurs. The malady is characterized by an excessive amount of gum formation which first arises from cracks produced in the trunk or branches. The gum collects in large masses on the affected parts. In advanced stages the gumming ceases and most often a bark rot follows. The disease is more severe in poorly kept orchards. The infectious type of the disease is usually found in localized areas of the citrus regions.

There are undoubtedly two forms of gummosis, one caused by a definite organism, another produced by some malnutrition of the tree, by insect punctures, or mechanical injuries. Insect injuries to the fruit often cause a gumming of the parts attacked. Gum may arise from portions adjacent to severe canker infections. When the disease is caused by malnutrition a general gummosis of the trunk and branches is more apt to be present.

The causal organism responsible for the infectious gummosis is the same as that causing bark rot and the dry, sooty, fruit rot. Infection experiment with *Diplodia*, carried out under the bark rot investigation, in all cases resulted in the formation of an excessive gumming as is characteristic with gummosis (Plate IV). Isolations from infectious gummosis cases in the field always gave the characteristic *Diplodia* that is more fully discussed under bark rot.

Spraying with Bordeaux mixture has been found to be an effective control measure for the infectious type. Trees that have been regularly sprayed on the College farm during the past years are relatively free from the disease. The use of Bordeaux paste has, however, proved to be more effective. Severe localized infections should be first cut out with a sharp knife, care being taken to remove all diseased tissue. The paste should then be applied with a stiff brush on the affected parts. In severe cases of infection the entire trunk and larger branches should be painted with the mixture. If the disease is due to malnutrition the trouble can be checked by proper fertilization and culture. As the fungus associated with the dry, sooty rot of the fruit, and that found on dead branches of citrus is similar to the *Diplodia* found in gummosis, a general cleaning up of all fallen fruits and twigs is beneficial. This rubbish is a source of infection and it should be burned.

LICHENS. UNDETERMINED

Lichens are found in abundance on all woody parts and even upon the leaves of trees. Greenish gray blotches are produced. The damage done appears to be slight, but nevertheless the normal physiological activities of the plant are disturbed.

Lichens can be reduced by the use of a spray or a wash of six per cent copper sulphate solution or by judicious spraying, as discussed under citrus canker. Care should be taken so that only the old woody parts of the trees are sprayed.

MOTTLED LEAF. NON-PARASITIC

Leaves diseased with mottled leaf are characterized by a distinct yellowing of the leaf mesophyll between the large lateral veins. The tissue adjacent the midvein and the larger lateral veins is a healthy green (Plate VI, fig. 1). Entire trees may be affected, but often only leaves on certain branches are diseased. When the first condition occurs, the tree is much dwarfed and may be killed in this weakened condition due to the entrance of secondary agencies. Badly diseased trees commonly show witches-broom effects and a more or less complete rosette of the leaves.

The disease is non-parasitic and is due to some disturbance of the normal physiological activities of the plant. It is not transmitted from one plant to another. Sometimes in air layering, the disease is produced on branches, the bases of which have been encircled by a coconut husk containing earth.

Since the disease is little understood, no definite control can be given. Badly affected trees should be removed, for they are stunted and will never produce normal fruit.

PINK DISEASE. *Corticium salmonicolor* BERKLEY et BROOME

Pink disease may be severe during the rainy season in poorly kept orchards. The fungus is a common one, which invades other woody plants. Infection starts on the trunk or branches, usually in some damp pocket. It is first noticed by the production of cracks, and by an exudate of gum. As the fungus penetrates into the bark, it spreads under the surface and causes a more or less cankered condition. In the latter stages the bark cracks and dries up. The fungus may penetrate through the bark into the cambium and wood. When a branch or trunk of a small tree is girdled and the xylem is invaded, the upper parts of the plant gradually die, due to starvation. Diseased trees are easily identified because of their dead branches. The affected area in certain stages of development, especially during the rainy season, is covered with a mass of pink mycelium that often extends over the bark in strands (Plate X, figs. 4, 5, and 7). During dry weather the mycelium dries considerably and is not so evident, since it changes to a dirty white or gray.

The disease is widely spread throughout the Philippine Islands and has been present for years. It has been observed on various plants growing near Manila, Los Baños, and in the province of Ambos Camarines. The malady is also present in Mindanao. It undoubtedly occurs in many other sections. Fruit trees, ornamentals, and forest trees may be attacked. The fungus probably spreads from some forest trees to cultivated plants, since it is more severe in neglected orchards which have grown up to underbrush. In Mindanao, the organism has been found in the Bukidnon region attacking *Citrus aurantifolia* (Christm.) Swingle, and *Gliricidia maculata* HBK.

As yet the disease has not made its appearance in the rubber plantations on the island of Basilan. Precautions should be taken to prevent its introduction into these plantations.

Besides the hosts mentioned, *Corticium* has been observed on the following: *Algaria* sp., *Allamanda cathartica* Linn. (Plate X, fig. 1), *Annona muricata* Linn, (Plate X, Fig. 3). *Annona reticulata* Linn., *Annona squamosa* Linn. (Plate X, fig. 6), *Artocarpus integra* (Thunb.) Merr. (Plate X, fig. 2), *Bauhinia* sp., *Cecropia palmata* Willd., *Citrus aurantium* Linn., *Citrus limonia* Osbeck., *Citrus hystrix* DC., *Citrus medica* Linn., *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck), *Citrus nobilis* Lour., *Coffee arabica* Linn., *Cordia myxa* Linn., *Duranta repens* Linn., *Eranthemum* sp., *Eugenia* sp., *Gardenia florida* Linn., *Gliricidia sepium* (Jacq.) Steud., *Malpighia glabra* Linn., *Mangifera indica* Linn., *Melia azedarach* Blanco., *Mussaenda luteola* Hochst., *Nerium indicum* Mill., *Nothopanax crispatum* (Bull.) Merr., *Panax* sp., *Streblus asper* Lour., *Tabernaemontana pandacaqui* Poir., and *Zizyphus jujuba* Lam.

The fungus, primarily during damp rainy days, produces on older infections an orange growth which yields an abundance of spores. The disease is spread by these spores. The mycelium is large, thick-walled, and resistant, which enables it to withstand long periods of drying.

Since healthy, vigorous trees, growing under well-cultivated and -aerated conditions, are less liable to attack, proper culture methods should be practiced. Spraying non-infected trees, as in the case of citrus canker, will exclude the fungus. Once it has gained entrance into and under the bark, however, spraying will do no good. Young infections may be removed by cutting out all the diseased portions well down into the healthy wood and painting the wound with a creosote paint or white lead. All badly diseased branches should be pruned and destroyed by burying. They should be cut from 15 to 20 centimeters below the visible extent of the disease, for the mycelium often penetrates farther than can be seen with the unaided eye. All large wounds should be painted with a creosote paint or white lead. Severely infected trees should be cut down and burned immediately.

ROOT ROT. UNDETERMINED

A rotting of roots resulting in the yellowing of the leaves and eventually the death of the tree may take place. The causal factor has not been determined. The disease is most common with citrus planted in wet, unfavorable locations.

SCALY BARK

A disease characterized by a scaling of the bark is common, but the causal factors have not been determined. Insects attack the tree just under the bark and cause a sloughing, but they do not appear to be the only factor.

SOOTY MOLD. *Meliola citricola* SYDOW

Frequently a sooty mold is found growing over leaves, stems, and fruit. It is superficial, growing on the sugary exudate of aphids and mealy bugs. *Coccus viridis* (Green) is most commonly found on trees severely affected. A mealy bug, *Pseudococcus* sp. is frequently found on branches, leaves, and fruit. The fungus has been observed on *Citrus medica* Linn., *Citrus nobilis* Lour. and on *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck) and undoubtedly occurs on other *Citrus* species.

A dense mass of brown to black mycelium, with its characteristic hyphopodia, is produced over the affected area. Setae and dark brown spherical perithecia

are produced from the mycelium. Within the perithecia are found the hyaline globular asci with from two to four, typically five-celled brown ascospores.

The disease may be controlled by spraying with lime-sulphur, which will tend to keep the aphids under control as well as to destroy the fungus.

SPINY MOLD. IMPERFECT FUNGUS

A spiny mold may be produced on leaves, stems, and fruit. Black tufted masses of fungus appear in spots or frequently in masses, covering the entire affected portions. The fungus grows primarily on a secretion from aphids.

A dense mass of brown mycelium, with numerous setae, is produced. The setae are septate and much elongated and they give a tufted appearance. Hyaline, elongate, sometimes crescent-shaped, granular spores are produced among the setae. The fungus has not been identified.

The control is similar to that discussed under sooty mold of citrus.

SPLITTING OF FRUITS. NON-PARASITIC

Often citrus fruits when ripe will split open after a heavy rain. Splitting may be associated with fruits attacked by a rindborer, *Tineina* sp. Fruit thus affected is gnarled or galled and the splitting may arise from the affected parts. Fruits injured in this way are apt to be attacked by rot producing fungi.

SUN SCALD. NON-PARASITIC

Trees that have been partially blown over by the wind and thus expose the trunk to the direct rays of the sun, frequently exhibit severe cases of sun scald. The entire upper sides of the trunks of such trees have a rotted area extending lengthwise. The bark at the edges of the rotted part is healthy. In advanced cases the killed bark sloughs off exposing the wood.

No organism has been associated with the trouble. The scalded parts afford a means of entrance for wound parasites. *Schizophyllum commune* Fr. may grow on the injured parts of weakened trees and cause a rot.

Trees blown over by the wind should be straightened up. The trunks should be whitewashed to deflect the sun's rays. Badly scalded trees should be painted with Bordeaux paste to prevent the entrance of wound parasites.

WITHER TIP. *Colletotrichum gloeosporiodes* PENZIG

A gradual dying of twigs and branches is frequently produced by the wither tip fungus. Not only the twigs, but the leaves and the fruit may be infected. The leaves wither, and the twig is killed and shrinks, leaving a definite line of demarcation between healthy and diseased wood. On the leaf, dark brown spots are produced. The fruit beneath a withered tip branch often becomes infected, which is evidenced by a russet appearance. Minute black specks are produced over the diseased surface.

The organism is indicated by the acervuli, produced in the form of black specks over the diseased parts. The acervuli are formed under the surface but later rupture it. Setae are produced, and from a dense mass of short conidiophores are produced the minute, cylindrical, granular, hyaline spores. The fungus grows well in pure culture, producing scanty mycelium, from which arise many small, black, fruiting bodies.

All diseased portions should be removed by pruning well below the visible advance of the disease. Spraying with Bordeaux mixture as discussed under citrus canker is effective.

Gloeosporium intermedium Sacc. may be found on injured citrus leaves. It produces minute black specks in the gray injured portions.

FUNGI PARASITIC ON SCALES

Aschersonia sclerotioides P. HENN. YELLOWISH, CIRCULAR AND FELTY

Aschersonia sclerotioides P. Henn. is parasitic upon the coccids listed under *Microcera*, but the fungus is not so prevalent as the others given as parasitic on scales. It is characterized by the production of a pinkish yellow, raised, circular, felty mass over the scales on stem and leaves. The mycelium does not penetrate the stem or leaf as it is parasitic only upon the coccids. The fungus is of economic importance.

Microcera coccophila DESM. RED FUNGUS

Microcera coccophila Desm., the red or pinkish fungus that attacks scales, is primarily responsible for the reduction of coccids on citrus trees. The fungus is confined to the insects and does not spread over the branches, leaves, or fruit. It consequently does not mar the appearance of fruit as is true with other fungi parasitic on coccids. The fungus is characterized by the production of reddish, club shaped, fruiting bodies either from one edge only or, as is more frequent, from the entire margin of the scale (Plate XI, figs. 1 and 3). In the latter case a red fringe of the fungus tissue is produced (Plate XI, fig. 3). Branches heavily infested appear to have a mass of pink spines produced from the surface (Plate XI, fig. 1).

It has been observed in spraying experiments with Bordeaux mixture or other copper sprays that the parasitic scale fungi are killed and the coccids increase in severity. Sprayed trees become thoroughly infested, which makes it necessary to use an insecticide from time to time to kill the insects. Spraying with Bordeaux mixture alone for canker control is frequently a detriment because of the increased scale attack. Under normal conditions the coccids are usually not serious even though a large number of species are found on citrus.

The following species of scales[6] have been observed to be attacked by *Microcera coccophila* Desm., and the other fungi parasitic on coccids: On fruit: *Chrysomphalus* (*Aonidiella*) *aurantii* (Mask.), *Lepidosaphes beckii* (Newn.), *Lepidosaphes gloverii* (Pack.), and *Pseudaonidia trilobitiformis* (Green). On living leaves and twigs; *Chrysomphalus aonidum* (Linn.), *Chrysomphalus* (*Aonidiella*) *aurantii* (Mask.), *Chrysomphalus dictyospermi* (Morg.), *Coccus viridis* (Green), *Lepidosaphes beckii* (Newn.), *Lepidosaphes gloverii* (Pack.), *Parlatoria brasiliensis* n. sp. M. S. *Parlatoria pergandii* (Comst.), *Parlatoria proteus* (Curt.), *Parlatoria ziziphus* (Lucas), and *Pseudaonidia trilobitiformis* (Green).

Myriangium duriaei MONT. BLACK, FELTY FUNGUS

Myriangium duriaei Mont. produces a black, felty growth over the various species of scales given under *Microcera*. The fungus is superficial, growing over the coccids on fruit, stem, and leaf. It does no direct damage to the tree. The

[6] Determinations by Harold Morrison, Bureau of Entomology, Washington, D. C.

number of scales on the fruit, branches, and trunk are reduced. On the fruit, the organism may cause a greater defect than the scales themselves, because of the production of the black, matted growth of mycelium which mars the appearance (Plate XI, fig. 3). The fungus is characterized by the black, thickened, stromatic mass of mycelium produced in irregular blotches over the affected parts. Roundish protuberances are produced on the stromatic mass. These blackened masses are frequently thickly scattered over the branches and often practically cover the infected parts. The usual size of the blotches are from three millimeters to two centimeters in diameter. Spraying with lime-sulphur or Bordeaux mixture will kill the fungus.

Septobasidium albidum PAT. BROWN, LEATHERY, AND THICK

Trees heavily infested with scales, frequently have the stems and leaves covered with the thick soft, leathery, brown growth of *Septobasidium albidum* Pat. The fungus is parasitic on the scales and whether it plays a very important part in the destruction of twigs is questionable. The attack by scale insects is usually sufficient to cause a serious set back to the tree. As the fungus completely covers branches, it has an injurious effect on the physiological processes of the parts attacked and may kill the young tender shoots. *Septobasidium albidum* Pat. is the most common species found. Spraying with lime-sulphur or Bordeaux mixture will kill the fungus.

Septobasidium michelianum (Cald.) Pat. listed in a host index by the writer[7] as occurring on *Citrus nobilis* Lour. according to Mr. N. Patouillard is an old form of *S. albidum* Pat.

Septobasidium reinkingii Pat. PURPLISH, LEATHERY, SMOOTH, AND THICK.

Septobasidium reinkingii Pat. may be found on the stem and leaves of citrus species (Plate XI, fig. 2). The fungus is at first superficial, usually starting as a parasite on scale insects. Later it may penetrate the young tender shoots and leaves. The coccids listed under *Microcera* are attacked. A thick, smooth, soft, leathery, purplish growth is produced over the affected parts. The fungus may spread over portions not infested with scales, although the initial growth in the majority of instances appears to start from the insects. It is characterized by its distinct purplish, smooth, leathery growth and is closely allied with *S. albidum* Pat., but is always deprived of probasidia. When young, tender shoots are overgrown, yellowing and death results. The fungus frequently completely covers young twigs and leaves. Leaf infections are characterized by the purplish growth, usually only on one side, and the yellowing of the leaf about the fungus and on the reverse side of the leaf. In severe cases of attack the young twigs and leaves are killed. The fungus is generally more destructive than the scales upon which the organism frequently starts its growth. Spraying with Bordeaux mixture, or better, lime-sulphur, will entirely control the infection.

BLACK, SPHERICAL, SCLEROTIAL BODIES. UNDETERMINED

Large, black, spherical fungus bodies from one to two millimeters in diameter, are frequently produced in abundance over citrus twigs infected with scales (Plate XIV, fig. 1). The fungus structures adhere closely to the twigs, but do not

---

7 Reinking, Otto A. Host index of diseases of economic plants in the Philippines. **The Philippine Agriculturist**, 8: 38-54. 1919.

penetrate, being parasitic on the coccids. The interior of the sclerotial body is yellow. The fungus may weaken the tree by upsetting the normal physiological relations. Spraying with a fungicide and an insecticide will reduce the infection.

SOUTHERN CHINA

DISEASES

The disease survey of citrus in Southern China was made by the writer during the months of May and June, 1919. The agricultural regions of Kwangtung Province and southern Kwangsi Province were studied. A report of these investigations was made,[8] and the part on citrus diseases with some changes and additions has been incorporated in the discussion which follows.

The citrus diseases of Southern China, as shown in the pages which follow, are in most respects similar to those in the Philippine Islands. One serious disease, citrus scab (*Cladosporium citri* Masse), which is present in China, so far has not been observed in the Philippine Islands. The conditions in the latter region do not appear to be proper for the development of the malady. But even so, strict inspection of all shipments from China should be made to exclude it or any new fungi. Another disease characterized by the production of black shiny specks on the twigs and leaves is common and serious in China. The causal factor has not been determined. Precautions should be used to exclude this malady.

The various citrus species and varieties are affected with canker to the same degree as in the Philippine Islands. Introductions of Chinese citrus have been made into the Philippine Islands and the following canker observations have been made on the young plants. Prof. G. W. Groff of the Canton Christian College, Canton, made the collections of the Chinese varieties and also obtained the local Chinese names.

Young plants of the Kat varieties (*Citrus nobilis* Lour.) grown under Philippine conditions at the College of Agriculture, Los Baños, are variously attacked. The Kat and Hung Kat may be severely infected. The Sun Kat, T'im Chue Sha Kat, Sun Chu Sha Kat, and Tim Hang Kat are only affected with a medium attack.

Little or no canker is present on old Kom varieties (*Citrus nobilis* Lour.) growing in China. Small plants introduced and growing under Philippine conditions show either a medium or severe infection. The Mat Tung Kom and Sun Kom varieties are severely attacked, while the Chiu Kom and T'im Kom varieties show only a medium infection.

Young lemon plants (*Citrus limonia* Osbeck) of various varieties growing under Philippine conditions are in most cases severely infected. The Pak Ning Mung and the Hung Ning Mung are badly infected.

Orange seedlings (*Citrus sinensis* Osbeck) may be severely attacked. Observations made on these plants growing under Philippine conditions gave the following results. Those severely infected are the varieties, T'im Chang, Lau Chang, Hang Chang, and Sun Chang.

The following pummelo varieties (*Citrus maxima* (Burm.) Merr.) growing under Philippine conditions are severely infected: Uen Shan Kong Yau, Pin Shan Kong Yau, Kom Suk Yau, Sha Tin Yau, In Chi Keuh, Song Ma Yau,

[8] Reinking, Otto A. Diseases of economic plants in Southern China. **The Philippine Agriculturist 8:** 109-134. Pl. 1-3, Nov. 1919.

Kam Lan Yau, Tau Yau, Wong Yau, Pan Yau, Ts'im Loh Yau, and Nin Yau. The varieties Kong Yau, and Song Ma Yau thus far showed only a medium infection.

LEMON. SOUR RED LEMON. NING MUNG. *CITRUS LIMONIA* OSBECK

BLACK SPOTS. UNDETERMINED

Black shiny spots are present on the leaves and stems. The disease is common and is serious. It is apparently either of a bacterial nature or is caused by some abnormal physiological conditions.

CANKER. *Pseudomonas citri* HASSE

The Ning Mung, or sour red lemon, is severely cankered on stem, leaf, and fruit. Brown raised cankered areas are formed on the affected parts. The infections extend through the leaves. Much damage may be done.

LICHENS. UNDETERMINED

Various kinds of lichens may be found growing over all woody parts, and even on leaves of the plants. The attack is especially severe on trees grown in areas subject to floods. Often the trees are entirely covered with large mossy structures. Severe damage is done in many cases. Although the lichen is superficial, it affects the normal activities of the trees to an extent which lowers their vitality and, consequently, their fruiting power. A wash composed of a six per cent solution of copper sulphate can be used to control the growth on the trunk and older branches.

SCAB. *Cladosporium citri* MASSEE

The leaves may be seriously affected. Brown raised portions are present in greatest numbers on the lower surface. The scab does not extend through the leaf, but on the upper surface there is a slight depression opposite the infected area. The disease is confused frequently with citrus canker. Spraying with Bordeaux mixture is effective as a control.

Septobasidium albidum PATOUILLARD

The stems and leaves of the sour red lemon are often covered with a thick, soft, leathery, brown growth (Plate XII, fig. 5). Since the fungus is parasitic on scale insects, it grows vigorously on branches severely infected with scale. Entire twigs and branches are killed. Whether the fungus plays a very important part in this destruction is questionable, since the attack by scale insects is usually sufficient to cause a serious setback. As the fungus completely covers branches, it has an injurious effect on the physiological processes of the parts attacked.

LEMON. SWEET RED LEMON. TIM HUNG NING MUNG. *CITRUS LIMONIA* OSBECK

BLACK SPOTS. UNDETERMINED

The black spots are present on the leaves and branches. No cause could be assigned.

CANKER. *Pseudomonas citri* HASSE

The sweet red lemon is attacked seriously on leaf, stem, and fruit.

LICHENS. UNDETERMINED

Lichens are severe.

LEMON. WHITE. NING MUNG. PAAK NING MUNG. *CITRUS LIMONIA* OSBECK

CANKER. *Pseudomonas citri* HASSE

The Chinese white Ning Mung may be severely injured by citrus canker. The fruit, stem, and leaves become gravely diseased.

Septobasidium, lichens, and black spots, also occur on this type of lemon.

MANDARIN ORANGE. KAT. *CITRUS NOBILIS* LOUREIRO

ALGAE. UNDETERMINED

Green and brownish algae often grow on branches and leaves. The vitality of trees is reduced by the attack. The algae do not penetrate into the tissues.

Aschersonia aleyrodis WEBBER

The fungus is parasitic on white flies and scale insects, and consequently is of great economic importance. It is characterized by a brown to cream-colored, circular, raised, craterlike growth, usually on the undersurface of leaves, but often on the upper surface also. The organism attacks only the white flies and the scales, and does not penetrate the leaf. In the Philippines it has been noted that scale insects are greatly increased on trees sprayed with Bordeaux mixture. This happens because the fungus parasitic on coccids is killed by the solution. The Kat is frequently severely attacked by the white fly, *Aleurocanthus citriperdus* Q. et B.,[9] and by scale insects. Such trees were observed to have an abundance of *Aschersonia.*

BLACK SPOTS. UNDETERMINED

The same disease that is found on lemons is present also on mandarins. Leaves and stems are affected. Apparently, little injury results.

CANKER. *Pseudomonas citri* Hasse

The canker on all of this species is relatively slight. A few leaf infections may be present, but no great damage is done.

LICHENS. UNDETERMINED

Lichens are commonly found in abundance on the trees. Serious losses result in many instances. The trouble is more fully discussed under sour red lemon.

SOOTY MOLD. *Meliola citricola* SYDOW

Leaves are often affected with a black sooty superficial growth. The fungus grows on the sugary secretion of aphids. The injury is slight, as a rule. On trees attacked severely, there is commonly a large number of woolly or other forms of aphids.

WITCHES BROOM. UNDETERMINED

Frequently, witches brooms, which are characterized by an abnormal production of twigs at the ends of branches, are present in abundance on the trees. The cause could not be determined in the limited time of the inspection. Also, a rosetted condition may occur.

---

[9] Determination by A. C. Baker, Bureau of Entomology, Washington, D. C.

On dead roots has been found *Hypoxylon serpens* (Pers.) Fr. Dead branches may be attacked by *Peroneutypa heterocantha* Sacc.

ORANGE. COMMON OR SWEET. CHANG. LAU CHANG. *CITRUS SINENSIS* OSBECK

Aschersonia aleyrodis WEBBER

Aschersonia is found in abundance growing on leaves attacked by scales (Plate XIII, fig. 5). The organism is very effective in killing scale insects, and is similar to that found on other citrus species. *Chrysomphalus ficus* Ashm. (*aonidum* (Linn.)), *Lepidosaphes beckii* (Newm.), *Lepidosaphes gloverii* (Pack), *Parlatoria pergandii* Comst., and *Parlatoria zizyphus* (Lucas)[10] are some of the scales that are found in large numbers on branches and leaves of orange trees.

BARK ROT. *Diplodia*

A rot of the bark similar to that found in the Philippines is common on orange trees in Kwangsi and Kwangtung provinces. The disease is caused by a *Diplodia*. At first, small black soft rotted areas are produced. Later, these increase in size and then the bark rots and falls off. The affection is usually accompanied by a frothing. In well cared for orchards no serious harm is done. Old, neglected trees are primarily infected.

BLACK SPOT. UNDETERMINED

The black greasy spots found on the leaves and stems of other citrus species are also prevalent on oranges. The cause was not determined.

BORER. *Melanauster chinensis* FORSTER

The stem borer of citrus causes enormous losses. Many times the trunks of trees are so severely weakened as to result in death. The borers open the way for fungi causing heart rots. *Schizophyllum commune* Fr. grows on dead trunks.

CANKER. *Pseudomonas citri* HASSE

Generally little canker is found on the various types of oranges (Plate XIII, fig. 4). In special cases, severe attacks have been noticed. The symptoms are similar to those discussed under lemon.

DIE-BACK

Trees grown under unfavorable conditions exhibit a serious die-back of the branches. The cause appears to be improper culture methods. Inter-cropping is, in many instances, over-practiced, if a high citrus yield is the primary aim. Oranges are in some instances inter-planted with mulberry, palms, bananas, and gabi. Sugar cane, beans, and gabi are frequently all used at the same time as intercrops. Trees in such orchards are necessarily over-crowded and as a consequence are weakened because of lack of nutrition and proper cultivation.

LEAF SPOT. UNDETERMINED

Often, following the ravages of the leaf miner (*Phyllocnistis citrella* Stainton), and a flea beetle, partially parasitic fungi gain an entrance to the leaf and cause a leaf spot. The invasion of the larva of the *Phyllocnistis* moth and the attacks of the flea beetle are severe and cause much loss, especially to nursery stock (Plate XIII, fig. 3). The larvae of the leaf miner also spread the citrus canker.

[10] Determination by Harold Morrison, Bureau of Entomology, Washington, D. C.

LICHENS. UNDETERMINED

Long mossy lichens and other types grow in abundance over trees in the flooded regions (Plate XII, fig. 1). They are present in such numbers as to greatly weaken the trees. A six per cent wash of copper sulphate used on the trunk and large branches is effective as a control.

MOTTLED LEAF. NON-PARASITIC.

Definite yellowed areas between the green colored main veins of the leaves is a common trouble. The cause of this malady is apparently some lack of food materials in the soil, or some disturbance of the normal activity of the trees.

ROSETTE

In certain localities, a rosetting of the leaves is common. The trouble is apparently caused by some abnormal physiological condition of the plant. No fungi were found associated with the disease.

SCAB. *Cladosporium citri* MASSEE

The common scab as described on other citrus is found also on the oranges. Generally, the attack is not severe.

Septobasidium albidum PATOUILLARD

Coccids are attacked also by a *Septobasidium.* The fungus may cause some injury to the tree by growing over branches infected with scale and in this way upset the normal physiological functions. The reduction of scale insects will control the fungus (Plate XII, fig. 6).

SNAILS. UNDETERMINED

On citrus growing in damp locations many snails may inhabit trees. Their presence seems to cause no injury.

SOOTY MOLD. *Meliola citricola* SYDOW

A black mold like that on other citrus is frequently found on orange leaves. The fungus grows superficial on the secretions of aphids, and consequently does little harm. The woolly aphids may be present in great abundance on trees.

YELLOWING

Trees grown under unfavorable conditions, as on poor soil and in heavily inter-cropped areas, exhibit an unhealthy yellowed appearance. In certain instances yellowing occurs in apparently well cared for orchards. The trouble in these cases may be from nematode attacks. A careful laboratory examination of such trees was not made. An excessive amount of water in the soil will cause a yellowing.

PUMMELO. YAU. SHA TIN YAU. *CITRUS MAXIMA* (BURM.) MERRILL (*CITRUS GRANDIS* OSBECK)

ALGAE. UNDETERMINED

As a common thing the leaves are covered with different species of algae. Lichens and algae are in greater abundance in orchards situated in damp location.

Aschersonia aleyrodis WEBBER

Aschersonia is usually prevalent on leaves attacked by scales. The fungus is parasitic on aleurodids and coccids, and consequently is beneficial. The leaf is not penetrated. The organism is similar to that on lemon trees. The white fly, *Aleyrocanthus citriperdus* Q. et B.[11] attacks the pummelo.

BLACK SPOTS. UNDETERMINED

Black shiny spots are produced on leaves and stems. The cause of this trouble could not be ascertained during the short inspection trip. The disease is similar to that on lemons and oranges.

CANKER. *Pseudomonas citri* HASSE

The canker may be severe on most varieties of pummelos. Apparently different forms show difference as to susceptibility. Leaves, stem, and fruit are attacked (Plate XII, figs. 3 and 4). The disease is similar to that discussed under lemon. The canker organism is present on trees growing above Wuchow, in Kwangsi, as well as through Kwangtung Province. The famous sand field pummelo or Sha Tin Yau of the Tang Yun district in Kwangsi is also attacked, but usually the older trees are not seriously affected.

EPIPHYTES. PARASITIC. *Loranthus parasiticus* (LINN.) MERRILL

Trees commonly are attacked severely by the plant parasite. In some cases the epiphyte grows completely over the trees. It spreads over the branches of citrus and forms root-like structures, or haustoria, which penetrate the tissues (Plate XIII, figs. 1 and 2). The plant is spread by seeds being carried from tree to tree by birds. The parasite can be easily controlled by pruning.

LICHENS. UNDETERMINED

Lichens may be severe on stems, branches, and leaves. Various species are present.

SCAB. *Cladosporium citri* MASSEE

Scab may at times be severe. It attacks leaves primarily, but is found also on the fruit. The disease is similar to that discussed under lemon.

Septobasidium carbonaceum PATOUILLARD AND *S. leucostemum* PATOUILLARD

The branches of pummelo, especially those severely attacked by scale, may be affected by these species of *Septobasidium*. The fungi are superficial, being parasitic on scale insects, and may be recognized by their brown, thick, leathery growth. Severe damage may be done when a large proportion of a tree is covered. The chief damage, however, is undoubtedly done by scales. Various species of scales, round, and oyster shell, are often in abundance. These include the following: *Lepidosaphes beckii* (Newm.), *Lepidosaphes gloverii* (Pack.), *Parlatoria pergandii* Comst., and *Pseudaonidia trilobitiformis* (Green.)[12]

SOOTY MOLD. *Meliola citricola* SYDOW

Not rarely, leaves are found covered with a black superficial growth. The fungus is on the leaf surface, growing on the secretions of aphids. No injury is done.

[11] Determination by A. C. Baker, Bureau of Entomology, Washington, D. C.
[12] Determinations by Harold Morrison, Bureau of Entomology, Washington, D. C.

On dead leaves may be found a species of *Diplodia*. And dead twigs are attacked by *Eutypella citricola* Speg., *Heterochaete tenuicula* (Lév.) Pat., *Tryblidiella rufula* (Spreng.) Sacc., and a *Phoma*. The *Phoma* may be similar to *Phoma omnivora* McA., or *Phoma citricarpa* McA., both of which give rise to diseases of citrus. The particular species collected was, however, upon dead twigs. Apparently it is not parasitic, or, if so, only slight. Although careful examination was made for a parasitic form of *Phoma*, none, was found.

TANGERINE. KOM. *CITRUS NOBILIS* LOUREIRO

SCAB. *Cladosporium citri* MASSEE

The Kom, or small tangerine, is frequently severely attacked by scab on the leaves and fruit (Plate XIII, fig. 6). The disease is similar to that found on lemons.

Black spot disease, witches broom, rosette, lichens, *Septobasidium albidum* Pat., and *Aschersonia aleyrodis* Webb. are present also on the Kom. Little or no canker is present.

CITRUS RELATIVE. *SEVERINA BUXIFOLIA* TENORE

ALGAE. UNDETERMINED

Leaves may be attacked by parasitic algae. Little damage is done. Black, circular, raised spots of the organism are characteristic of the trouble.

GALLS

Insect galls are frequently present on stems.

SOOTY MOLD. *Meliola*

A similar superficial black mold may cover the leaves as with citrus species.

CITRUS RELATIVE. WAMPI. *CLAUSENA LANSIUM* SKEELS

EPIPHYTES. *Loranthus parasiticus* (LINN.) MERRILL

This parasitic epiphyte causes severe destruction by growing over the trees. The plant bears haustoria, or root-like structures that pierce the host and absorb food materials. In severe cases of attack, the foliage of *Loranthus* may replace almost completely that of *Clausena*. The parasitic plant can be kept easily under control by merely pruning it out.

LICHENS AND ALGAE. UNDETERMINED

In damp locations the trunks and branches of trees may be covered with lichens and algae.

SOOTY MOLD. *Meliola*

A *Meliola* type of fungus frequently gives rise to black sooty spots. Since the organism lives superficially on the leaves, obtaining its food from the sugary secretion of aphids, the plant is not injured. The fungus may be the same species that is found on the various species of citrus.

INDO-CHINA

DISEASES

The résumé of the citrus diseases in Indo-China is based upon a study made in the vicinity of Saigon; in the Thudaumot (Tho Long Mot), and Ben Cat regions

north of Saigon; and in the region between Saigon, Pnompenh, and Kep, in Cambodia. The investigation was made during the month of May, which is in the extreme dry season. Consequently the diseases of the various species were not severe and possibly a number of maladies present during the rainy season were absent. The survey of diseases on citrus clearly shows, however, that the troubles are very similar to those found in the Philippine Islands. The various species and varieties of citrus in Indo-China appear to respond to fungus attacks in a similar manner to those grown in the Philippine Islands. Canker affects the species there in the same way, identically. No new fungi or diseases of importance were found in Indo-China. This would indicate that the possibilities of introducing any new organisms from that country upon citrus shipped into the Philippine Islands is practically negligible. A strict inspection of trees introduced, however, should be practiced as some unfound troubles may be present during the rainy season.

CITRON. THANH YEN. *CITRUS MEDICA* LINNAEUS

BARK ROT. *Diplodia*

The *Diplodia* bark rot may be severe on the citron.

CANKER. *Pseudomonas citri* HASSE

Canker attack is only medium on the citron.

DIE-BACK. UNDETERMINED

A die-back of seedlings, during the dry season, has caused much loss. Whether this is due to a lack of water or to a fungus was not determined. The fungus, *Cladosporium herbarium* (Pers.) Link, may develop as a black mold over the dead portions of the plants.

GUMMOSIS. *Diplodia*

Gummosis may be serious, especially on older weakened trees.

LEMON. *CITRUS LIMONIA* OSBECK

ALGAE. UNDETERMINED

Parasitic and non-parasitic algae may develop on stem and leaf. Generally little damage is done.

BARK ROT. *Diplodia*

The bark rot may be severe on the various varieties of lemon. The disease is similar to that discussed for the Philippines.

CANKER. *Pseudomonas citri* HASSE

A medium to severe canker attack is usually present on the different types of lemons. No extreme damage is done in the dry season except on seedling plants.

Young lemon plants introduced from Indo-China and growing under Philippine conditions are severely attacked with canker.

GUMMOSIS. *Diplodia*

A gumming of the trunk and stem may be found on trees attacked by the facultative parasite, *Diplodia*. The disease may be extremely serious on various varieties of lemons.

LEAF BLIGHT. *Phoma*

Leaves weakened by red ants, *Oecaphylla smaragdina* Faby.,[13] making nests are infected by a slightly parasitic fungus of the *Phoma* class.

LICHENS. UNDETERMINED

Lichens grow on trunks, branches, and leaves, but do little damage.

SOOTY MOLD. *Meliola citricola* SYDOW

A black mold is common on leaves and stems attacked by aphids and scale insects. Coccids of various species are found. They may be tended by the red ant, *Oecaphylla smaragdina* Fab.,[13] which carry the scales from place to place on the same tree or from one tree to another.

On dead stems was found the fungus *Tryblidiella rufula* (Spreng.) Sacc.

LIME. CHANH GIAY. CHANH NUOM. *CITRUS AURANTIFOLIA* (CHRISTM.) SWINGLE. (*CITRUS ACIDA* HORT., *CITRUS LIMONELLUS* HASSK.)

ALGAE. UNDETERMINED

Algae are commonly found on branches and leaves. Their presence is not considered serious.

BARK ROT. *Diplodia*

Bark rot is present and does some damage.

CANKER. *Pseudomonas citri* HASSE

Canker is severe on stem, leaf, and fruits. It causes serious losses to nursery trees and is also bad on older trees.

LICHENS. UNDETERMINED

Lichens develop on trunk, branches, and leaves, especially on trees growing in damp locations.

SOOTY MOLD. *Meliola citricola* SYDOW

The black mold is abundant on trees attacked by scales or aphids. Scales of various species are present including the following: *Parlatoria pergandii* Comst., and *Parlatoria ziziphus* (Lucas).

MANDARIN ORANGE. CAM SANH. *CITRUS NOBILIS* LOUREIRO

ALGAE. UNDETERMINED

Algae both saprophytic and parasitic may attack leaves and stems.

CANKER. *Pseudomonas citri* HASSE

On older trees the canker attack is generally only slight, but the disease may be severe on seedlings or small nursery trees. The organism may be spread by the common leaf miner *Phyllocnistis citrella* Stainton. The miner by itself causes serious damage to small plants.

MOTTLED LEAF. NON-PARASITIC

The true mottled leaf, characterized by a yellowing of the leaves between the normal green veins, may be common. The malady appears to be due to some malnutrition of the plant. No organism has been associated with the trouble.

[13] Determination by H. E. Woodworth, College of Agriculture, Los Baños, Laguna, P. I.

SOOTY MOLD. *Meliola citricola* SYDOW

A black superficial growth is often found over stems and leaves, in the presence of scales and aphids. Various species of coccids attack the mandarin orange. Among these are *Fiorinia theae* Green, and a *Pulvinaria* sp.[14]

On dead branches may develop the fungus *Tryblidiella rufula* (Spreng.) Sacc.

PUMMELO. CAY BU'O'I. *CITRUS MAXIMA* (BURM.) MERR. (*CITRUS GRANDIS* OSBECK)

ALGAE. UNDETERMINED

Algae are generally present on the leaf and stem. While they are often parasitic on leaves, little damage is done.

BARK ROT. *Diplodia*

Trees may be attacked by the common *Diplodia*, which produces a bark rot. The disease is similar to that discussed under the Philippines.

CANKER. *Pseudomonas citri* HASSE

Citrus canker which is common throughout the East on the pummelo, severely attacks the leaf, stem, and fruit of the species in Indo-China. The symptoms of the disease are similar to those discussed for the Philippines. The leaf miner *Phyllocnistis citrella* Stainton is severe, especially on nursery stock. It may spread the canker organism.

FRUIT ROT. *Diplodia*

A black sooty rot of pummelo occurs on fruit left on the ground or in storage. The organism producing the rot is the same as that which causes bark rot and gummosis. The orchards should be kept free from all diseased fruits.

GUMMOSIS. *Diplodia*

A gumming of the trunk and branches may result from the invasion of the fungus *Diplodia*.

LEAF BLIGHT. UNDETERMINED

A blighting of the leaf may result from various causes. Leaves used by the common red ant, *Oecaphylla smaragdina* Fabr., in making their nests are very much weakened and may be attacked by fungi that are slightly parasitic.

LICHENS. UNDETERMINED

Lichens frequently attack the trunk, stems, and leaves. Their presence is most abundant during the rainy season and in orchards located in damp places. Little damage is done.

SOOTY MOLD. *Meliola citricola* SYDOW

The presence of aphids and scales is usually indicated by a black fungus growth over the affected parts. The fungus is superficial, living from insect secretions, and does little harm. Scales of various species may be serious on stems, leaves, and fruits. The following scales were collected: *Chrysomphalus aurantii* (Mask.), *Coccus mangifera* (Green), *Lepidosaphes beckii* (Newm.), *Lepidosaphes gloverii* (Pack.), *Parlatoria ziziphus* (Lucas), *and Pseudaonidia trilobitiformis* (Green).[14]

[14]Determinations by Harold Morrison, Bureau of Entomology, Washington, D. C.

On dead stems have been found the following fungi; *Heterochaete tenuicula* (Lév.) Pat., and *Tryblidiella rufula* (Spreng.) Sacc.

CITRUS RELATIVES

Canker was not observed on the following various citrus relatives: *Clausena lansium* (Lour.) Skeels, Quat Hong Bi; *Feronia elephantum* Correa, Can Thang; *Fortunella japonica* (Thumb.) Swingle, Cay Quat; and *Murraya paniculata* Linn., Nguyet Quo'i. An *Atalantia* sp. may be severely attacked by the scale, *Aspidiotus cocotiphagus* Marlatt.

SIAM

DISEASES

The study of citrus diseases in Siam was made during the months of June and July. While the season was still dry, it is believed that the major diseases were encountered. The severity of these troubles undoubtedly is much greater during the rainy season and some maladies other than those herein treated, may then be present. A comparison of the diseases in Siam and the Philippine Islands shows that they are essentially the same. Some few leaf troubles and a gall formation on trees in Siam appear to be new to the Philippine Islands. Careful selection of healthy plants for shipment, and strict inspection in the Philippine Islands will avert any possibility of introducing a dangerous fungus.

Citrus canker is the same in general formation on the various species and varieties of citrus growing in Siam and the Philippine Islands. *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck), and *Citrus aurantifolia* (Christm.) Swingle are severely attacked in both regions. *Citrus nobilis* Lour. and *Citrus nobilis* Lour. var. *deliciosa* Swingle are not so severely attacked. It is to be regretted that one of the best pummelos of Siam, the Nakorn Chaisri seedless, is the most delicate and consequently most apt to be severely attacked by canker and other diseases. An extensive study of the various varieties may show some slight resistance, but in general all of this type are attacked. There are other varieties of pummelos, the Kao Phuang and allied forms, which are hardy and less subject to attack by the canker organism, and by fungi which produce other diseases. Because of these factors, the Siamese orchardists produce for export, primarily only one type of pummelo, the Kao Phuang, or bell-shaped variety. The tree is healthy and vigorous; it bears heavily; and the fruit ships well. The quality and seedless character, however, are lacking, and for local consumption, especially for the exacting consumer the more delicate and better flavored forms are produced. The price obtained for these better varieties is much higher as the demand is strong and the production is low.

The best types such as the Nakorn Chaisri seedless and the Koon Non ship extremely well when properly handled. The writer made shipments of the Nakorn Chaisri seedless variety to the Philippine Islands. The fruit was picked in June and shipped to the Islands in July, wrapped individually in paper and packed in a bamboo-strip basket. The fruits arrived in excellent condition and were still good on August 15. Properly picked, under good shipping conditions, and ordinary storage conditions, the fruit will remain in excellent shape for two or three months. The Koon Non variety also ships and stores well. Fruits, not quite mature, picked on July 1, dumped into a sack and placed in a bamboo-strip bas-

ket, shipped exceptionally well to the Philippine Islands and were still in the best of condition and of the highest quality on August 24. Fruit rots due to *Mucor* and *Diplodia* may take place while in storage, especially on fruits that have been injured during picking and handling. This trouble can, however, be entirely avoided by proper handling and shipping. In order to obtain the highest possible yield of unmarred fruits of these varieties, the best of culture and care will have to be exercised. With this attention the Nakorn Chaisri, and Koon Non varieties of pummelos can be commercially produced and shipped. A more extensive study of these types should be undertaken to determine whether or not a more resistant strain can be developed.

Since the diseases, as listed below, are practically all treated under the Philippine Islands, a complete discussion of symptoms and control is not here given.

CITRON. *CITRUS MEDICA* LINNAEUS

CANKER. *Pseudomonas citri* HASSE

The canker attack on the citron is usually only medium.

LEAF BLIGHT. UNDETERMINED

A leaf blight of the citron has been observed, but it is not serious. It probably is due to a lack of water combined with the effect of the sun.

SCALES

Scales may be severe on stem, leaf, and fruit. The following have been determined: *Lepidosaphes gloverii* (Pack.) and *Parlatoria ziziphus* (Lucas.)[15]

LIME. SMALL, MANOW KLOM. LARGE, MANOW YAI *CITRUS AURANTIFOLIA* (CHRISTM.) SWINGLE

ALGAE. UNDETERMINED

Algae develop on the stem and leaves.

CANKER. *Pseudomonas citri* HASSE

Canker is severe on the stem, leaves, and fruit of all the limes. Throughout the East, the limes are all susceptible. The Manow Klom, Manow Yai, and giant lime varieties when grown under Philippine conditions are severely affected.

EPIPHYTE. PARASITIC. *Loranthus parasiticus* (LINN.) MERRILL

The common parasitic epiphyte infests the lime trees.

LEAF SPOT. UNDETERMINED

An undetermined leaf spot may cause a serious defoliation. Small, brown spots with black centers are found. The causal organism is now under investigation.

LICHENS. UNDETERMINED

Various species of lichens usually are present on the trunk and branches.

SOOTY MOLD. *Meliola citricola* SYDOW

A black mold may develop over the leaves. It grows on the secretion of aphids and is not generally serious.

On dead branches may be found the fungus *Heterochaete tenuicula* (Lév.) Pat. It only develops as a saprophyte.

[15] Determinations by Harold Morrison, Bureau of Entomology, Washington, D. C.

LIME. MAGRUD. *CITRUS HYSTRIX* DE CANDOLLE

ALGAE. UNDETERMINED

A brownish alga may be found in abundance on the leaves.

CANKER. *Pseudomonas citri* HASSE

The canker is severe on the leaf, and may be found on the stems, and fruit.

EPIPHYTES. *Loranthus parasiticus* (LINN.) MERRILL

The common epiphyte also attacks the Magrud and if it is not cut out it causes serious damage.

GALLS. UNDETERMINED

A severe gall formation may develop on the trunk and branches (Plate XIV, fig. 3). The cause is unknown, but preferably all such trees should be removed and burned to prevent the spread to other species and varieties.

MANDARIN ORANGE. SOM KEO WAN. *CITRUS NOBILIS* LOUREIRO

CANKER. *Pseudomonas citri* HASSE

Only a slight attack of canker occurs on the mandarin orange. This variety shows resistance to canker throughout the Orient. Introduced young plants growing under Philippine conditions at the College of Agriculture, Los Baños, are only slightly attacked.

ORANGE. COMMON OR SWEET. SOM KLEANG. *CITRUS SINENSIS* OSBECK

BARK ROT. *Diplodia*

A bark rot similar to that discussed under pummelo is also present on oranges. In neglected orchards the trees may be seriously attacked. The disease is due to a common *Diplodia* found in practically all orchards and is more fully discussed under diseases of the Philippines.

CANKER. *Pseudomonas citri* HASSE

The canker attack on the Som Kleang is rather slight in comparison to that on the pummelo. No serious damage is done. Throughout the entire East, the orange is generally not so severely attacked as the pummelo. The severity of the disease on other varieties of oranges is as follows; on the Som Tra Epa, medium; on the large orange or Som Keo, medium; on the Som Chine, medium; on the Som Chuke, medium; and on an introduced Washington Navel, medium.

EPIPHYTE. PARASITIC. *Loranthus parasiticus* (LINN.) MERRILL

The common *Loranthus* as discussed under pummelo may cause serious losses to orange trees. All epiphytes should be cut out as soon as they appear.

GREASY SPOT. NON-PARASITIC

Black, raised, greasy spots may be produced on the leaves. No organism has been associated with the trouble. It does little harm.

GUMMOSIS. *Diplodia*

A severe gumming may take place on weakened trees. The disease is either due to the parasitic *Diplodia* or, in some cases apparently is caused by malnutrition.

LICHENS AND ALGAE. UNDETERMINED

Lichens and algae are commonly found on the trunk, branches, and leaves. Little damage is done.

MOTTLED LEAF. NON-PARASITIC

The characteristic mottled leaf, with a yellowing of the leaves between the main veins which remain a healthy green, is common in poorly kept plantations. The disease appears to be due to malnutrition. The trouble is not serious.

RUSSET. UNDETERMINED

A russetting of the fruit may be serious. The causal factor was not determined. It is either caused by the wither tip organism, *Colletotrichum gloeosporioides* Penz. or by rust mites. Neither of these was observed at the time of the investigation.

Septobasidium albidum PATOUILLARD

Septobasidium albidum Pat. frequently invades scales. Scales of various species may attack the leaf, stem, and fruit. Little damage is done. The following coccids have been identified: *Lepidosaphes gloverii* (Pack.), *Parlatoria pergandii* Comst., and *Parlatoria ziziphus* (Lucas).[16]

SOOTY MOLD. *Meliola citricola* SYDOW

A black sooty mold may be produced over leaves that are attacked with scales or aphids.

PUMMELOS. SOM-O. *CITRUS MAXIMA* (BURM.) MERR. (*CITRUS GRANDIS* OSBECK)

Bangkok, Siam, is especially noted for its excellent pummelos. A large number of varieties including the following are recognized: Nakorn Chaisri seedless pummelo, sometimes called Kao Pan; Koon Non, (Bang Koon Non); Dang Ai Chea, red or pinkish; Hom Bai Teoy, sweet scented; Thong Dee; Kao Phuang, bell shaped; Kao Yai; Kao Lang Sad; Kao Ruan Tia; Kao Phoeng; and Kao Wan.

The diseases listed below as occurring on pummelos may be found on all of these varieties. There, however, appears to be a difference in the susceptibility to disease, of varieties in the various groups. The Nakorn Chaisri seedless pummelo, sometimes called Kao Pan, is extremely delicate and is subject to the diseases in their most destructive forms. This is especially true in neglected plantations. The tree needs constant attention and care. The Koon Non variety resembles very much the Nakorn Chaisri seedless type, and also is rather delicate, but seems to be somewhat hardier. The Kao Phuang, bell-shaped variety, is an extremely hardy and vigorous growing tree. It and the other Kao varieties listed above are not so apt to be seriously attacked by fungi. All varieties of pummelos, especially young trees, show some difference in resistance according to the various types and varieties. The Nakorn Chaisri seedless variety is extremely susceptible, but the Kao Phuang and its associates appear to be less attacked.

---

16 Determinations by Harold Morrison, Bureau of Entomology, Washington, D. C.

ALGAE. PARASITIC. UNDETERMINED

Parasitic algae may produce a leaf spotting which, however, is not serious.

Aschersonia aleyrodis WEBBER

Scale insects on citrus trees may be attacked by the *Aschersonia* discussed under diseases of citrus in Southern China. It is a beneficial fungus reducing the number of coccids. Scale insects of various species, as listed later, may be severe on stem, leaves, and fruit of pummelos.

BARK ROT. *Diplodia*

The common bark rot as discussed under diseases for the Philippines may also attack the pummelo, but does not appear to be serious.

CANKER. *Pseudomonas citri* HASSE

On the Nakorn Chaisri seedless, or Kao Pan, variety the canker is extremely serious on all trees, attacking the leaf, stem, and fruit. There does not appear to be any individual variation as to susceptibility. Brownish, cankered areas are produced on the affected parts. The growers do not consider the disease to be a serious one and consider the cause to be due to a caterpillar or some other insect. If only a few cankered infections develop on the fruits the planters say that the sale is not hindered, but if the affection is severe the price obtained for such fruit is somewhat lower. The great demand, especially Chinese, for the best types of fruit and their comparative scarcity accounts for their ready sale even though defaced. The growers recognize the fact that a rot does not start from the cankered area.

The canker appears to be more prevalent in well-kept plantations where the trees are vigorous. In neglected orchards not so much canker is in evidence. Counts of cankered fruits of the Nakorn Chaisri seedless variety in storage gives some indication of the severity of the disease. Out of 128 fruits examined, 74 or 58 per cent were found to be more or less severely cankered.

The disease is also serious on practically all the other varieties of pummelos as listed above, especially on the young trees. Apparently the Kao Phuang, or bell-shaped, and the other Kao varieties are somewhat more resistant. They all, however, are subject to the disease, but the older trees are rarely seriously damaged and the fruit is relatively free from infection. No canker infection was observed in the plantation of the Koon Non variety, but it seems highly probable, because the variety resembles the Nakorn Chaisri seedless, that further investigation, especially during the rainy season, will prove this type to be affected.

Young plants introduced and growing under Philippine conditions at the College of Agriculture, Los Baños, are badly affected. Severe canker infections occur on the Kao Pan, Kao Phuang, and the Kao Ruan Tia varieties. The Koon Non variety thus far shows only a medium infection.

No canker was observed on the bael fruit, *Belau marmelos* Lyons.

EPIPHYTES. PARASITIC. *Loranthus* species

The most serious trouble on the citrus trees in general is the *Loranthus*, of which there are the following species: *Loranthus ferrugineus* Roxb., *Loranthus parasiticus* (Linn.) Merr., and *Loranthus pentandrus* Linn. (Plate IX, figs. 2,

and 3). *Loranthus parasiticus* (Linn.) Merr. is the one most commonly found. If the epiphyte is not cut out it soon envelops the entire tree. The parasite has a wide range, being found on mango, mangosteen, durian, and native trees, *Bruguiera sexangula* (Lour.) Poir., used to line dikes. Care should be taken to remove the epiphyte from all trees affected. The leaf miner, *Phyllocnistis citrella* Stainton may also attack the *Loranthus* leaves.

FRUIT ROT. *Diplodia*

Fruits in storage or those that have been allowed to decay on the ground are frequently subject to a black rot caused by *Diplodia*. The trouble is not serious. Fruit rots are not common on the trees or in storage. Rough handling during picking and storing makes the fruit more subject to rot. All black rotted fruits should be collected and burned as the fungus causing the disease is the same that produces bark rot and gummosis.

FRUIT ROT. *Sclerotium*

A *Sclerotium* may cause the rot of fruits that have fallen on the ground. Such fruits have small, spherical, brownish, sclerotial bodies formed over the decayed area.

GUMMOSIS. *Diplodia*

Gummosis may be severe in neglected orchards. It is of two kinds, that due to *Diplodia* and that due to malnutrition.

LICHENS. UNDETERMINED

Lichens of various sorts are found on trunk, branches, leaves, and fruit. Little damage is done.

MOTTLED LEAF. NON-PARASITIC

A typical mottled leaf with the yellowed areas between the green veins is common, but is not considered serious.

RUSSET. UNDETERMINED

Fruits may be russetted. Whether this is due to injury by rubbing against branches or due to fungi could not be determined. In some cases the disease appeared to be a typical case due to the wither tip fungus *Colletotrichum gloeosporioides* Penz.

SCALY BARK. UNDETERMINED

Old neglected trees are subject to a rotting of the bark and a consequent sloughing of the dead parts. The trouble is only serious in older, poorly kept orchards. It is not a typical bark rot.

Septobasidium albidum PATOUILLARD

A thick, brown leathery growth of the fungus is produced over stems attacked by scales. Usually no damage is done by the fungus.

SOOTY MOLD. *Meliola citricola* SYDOW

A black mold may develop on leaves and stems especially in the presence of scale insects. The trouble is not serious.

WITCHES BROOMS. NON-PARASITIC

In poorly kept orchards, improperly pruned, witches brooms may develop on the branches. The trouble is not serious.

YELLOWING OR CHLORATIC CONDITION. NON-PARASITIC

During the extreme dry season, the trees may look sickly, being yellowed. It is most common where improper irrigation is practiced. The Nakorn Chaisri seedless pummelo is not a hardy and healthy tree, so consequently it is easily weakened by unfavorable conditions. Often, due to neglect, the trees are old at ten years of age. Well-kept orchards have healthy trees, free from the majority of serious plant pests, and have been producing fruit for thirty years. The age of the tree is frequently dependent upon the care given and the extent of the dry season. Healthy trees produce most abundantly between eight and fifteen years of age. In poorly kept orchards, during the extreme dry season, the trees are sickly, with leaves wilted, dropping off, and with a die-back of the branches. The trees will not stand flooding. The greatest number of seedless pummelo trees in the Ban Mai section have died either due to lack of attention or due to heavy floods. The owners are not replanting with the same trees, because they are delicate and require a good deal of attention. They recognize the hardiness of the Kao Phuang pummelo and are planting this variety.

On dead branches may develop the following: *Schizophyllum commune* Fr., *Tryblidiella rufula* (Spreng.) Sacc., and *Heterochaete tenuicula* (Lév.) Pat.

SOM-SA. *CITRUS*

CANKER. *Pseudomonas citri* HASSE

The Som-sa, of which the peel of the fruit is used as a condiment in the preparation of many curry dishes, is only attacked to a medium extent by canker. Young plants growing under Philippine conditions are severely attacked.

TANGERINE. *CITRUS NOBILIS* LOUREIRO

ALGAE. UNDETERMINED

The leaves may be specked with a black alga which is of little consequence.

EPIPHYTE. PARASITIC. *Loranthus pasasiticus* (LINN.) MERRILL

The *Loranthus* seriously attacks the tangerine.

SCALES

The scale, *Parlatoria ziziphus* (Lucas), infects both stem and fruit.

INSECTS

As insect attacks frequently open a way for the entrance of fungi, it was thought advisable to note those most commonly observed. The leaf miner, flea beetle, ants, and scales do the most damage.

ANT. MOD DAM. *Dolichoderus* SPECIES[17]

A harmless black ant is often found on the leaves, especially in the vicinity of scale insects. These ants tend the scales for their sweet secretions.

[17] Determination by H. E. Woodworth, College of Agriculture, Los Baños, P. I.

ANT. MOD KAN FIE. *Pheidologeton* SPECIES[17]

A reddish, or fire ant, so called because of its burning bite, may cause serious damage even to the extent of killing some of the trees. The ant attacks and kills the young roots, and also is reported to attack the older roots, the trunk, just below the ground surface, and even the young twigs and leaves. In some cases the ants girdle and kill the trees. Parasitic and rot producing fungi frequently gain entrance to the tree through ant injuries. Fruit touching the ground may be attacked by ants and other insects thereby opening a way for fungi. The control consists in flooding out the ants and burning them. In October and November when the water is high, during the flood periods, the growers allow the water to flow over and stand on the fields for from two to three days. By this method the ants are forced out of the ground. They come to the surface and seek the highest points of land. The owner then travels about with a lighted torch of long grass and burns them. Termites, small red ants, and black ants are killed also in this way.

FLEA BEETLE

Flea beetle attack on the leaves is characterized by the epidermal layer and the mesophyll being eaten away on one side of the leaf down to the epiderminal layer on the other side. Severe injury may be done. The same insect is found in China.

LEAF MINER. *Phyllocnistis Citrella* STAINTON

The leaf miner may cause much loss, especially on young nursery trees (Plate XIV, fig. 2). The miner seems to prefer the young leaves. Badly attacked young leaves are stunted, wrinkled, and rolled up. On older trees the attack is not so noticeable. The insect may spread canker infections.

RED TREE ANT. MOD DANG. *Oecaphylla Smaragdina* FABRICUS

Oecaphylla smaragdina Fab., the large red or cedar colored tree ant is common on the branches of trees. It does no damage to the tree directly, but makes nests out of the living leaves. The ants tend scales and other insects for the secretions from their bodies. They are found throughout the East, and are a pest during harvest time when they attack and bite the pickers.

In the citrus groves around Canton it is reported that the orchardists import the ants and place nests of them on the trees to destroy caterpillars, probably tent caterpillars, which at times do serious damage. The trees in orchards are connected by bamboo poles to enable the ants to pass from tree to tree.

SCALES

Scales may be present in abundance on stem and leaves of pummelos. The following have been identified: *Chrysomphalus aonidum* (Linn.), *Chrysomphalus aurantii* (Mask.), *Coccus hesperidum* (Linn.), *Lepidosaphes gloverii* (Pack.), *Parlatoria brasiliensis* n. sp., *Parlatoria ziziphus* (Lucas), *Pseudaonidia trilobitiformis* (Green,) and *Saissetia* sp.[18] An examination of fruits in storage showed only 2 out of 37 or .05 per cent to be attacked.

---

[18] Determinations by Harold Morrison, Bureau of Entomology, Washington, D. C.

TERMITES. PLUAG. *Termes* SPECIES

Termites do some damage by eating the roots. No serious losses are produced.

CONTROL MEASURES

The control of plant diseases involves principally a prevention of infection by the fungus. It is therefore important to understand the nature and the cause of the malady. The brief descriptions given of the diseases, together with designations of the causal organisms, indicate the various control measures that may be practiced. Besides the specific controls given, it must be remembered that general cultural measures should be looked to for fundamental control of the diseases. Such measures include careful preparation of the soil, the correct method of planting, sufficient distance between plants, just the right amount of shade, favorable soil, locations adopted to crops, and the proper methods of cultivation, pruning, and other practices commonly employed to produce a healthy and vigorous plant and a maximum yield. Plantations in which these methods of agriculture are a routine obtain higher yields, not only because of better culture, but also on account of the reduction of insect and fungus attacks.

The selection of disease-resistant varieties has received the most prominence of recent years in the control of diseases. Certain varieties of plants are attacked less than are others. Control by the use, when possible, of disease-resistant varieties is the cheapest and best method. It is not always possible to produce resistant strains, but the grower should select those varieties that are least subject to attack. Disease resistance is clearly shown by the varying degrees of susceptibility to canker of the various species of citrus.

It is also of the utmost importance to prevent the introduction of any new diseases into the Philippines and to prevent the spread of a disease from one section of the Islands to another. This can be accomplished by the strict enforcement of inspection and quarantine measures. Usually governments do not act until great loss and heavy infection have occurred. The writer has had an opportunity to study the disease of citrus in Formosa, Southern China, Indo-China, Siam, and Federated Malay States, and a description of the most important of these has been given so that those not found in the Philippine Islands can be excluded. Citrus varieties from all countries of the East have been and will continue to be introduced into the College of Agriculture at Los Baños. Consequently, it is of significance that the fungi and insects of citrus growing in these localities be determined. Below are treated the specific controls applicable to citrus diseases.

SOIL STERILIZATION

For the control of a large number of fungi, specific measures can be carried out on a practical basis. The soil of the tropics contains many fungi, some of which are highly destructive to young, tender, plants. These fungi, as before discussed, include the following: *Pythium debaryanum* Hesse, *Rhizoctonia*, and *Sclerotium*. All may cause destruction by a damping off of seedlings grown in seed beds. This trouble can be prevented easily by soil sterilization. Although no practical method for large areas has been devised, still, soil used for growing seedlings can and should be thoroughly sterilized. There are two methods, namely, to heat the soil directly or to use disinfectants.

DIRECT-HEATING METHOD

The best method of soil sterilization for the Philippine Islands, under the ordinary conditions, consists merely in heating the soil on a piece of sheet iron. A piece of iron 95 centimeters by 160 centimeters is raised about 50 centimeters above the ground by means of iron posts. Moist garden soil is shoveled on the sheet iron, and a fire is built underneath. The soil should be thoroughly heated for from thirty minutes to one hour, taking care that the humus is not removed by burning. The organic material of the soil should not be burned. A temperature from 60°C. to 100°C., just high enough so that a person cannot pick up the soil in his hands, is sufficient. The sterilized soil should then be shoveled into seed flats that have been thoroughly dried in the sun, or better still, disinfected with a two per cent formalin solution. The soil is ready for planting as soon as it cools.

COPPER SULPHATE DISINFECTION

A one per cent solution of copper sulphate has also proved entirely satisfactory in controlling damping off. Three and one half liters of this strength of solution must be sprinkled over each square meter of seed bed, immediately after the seeds are sown. The cost of the treatment is only three centavos for each square meter of treated soil. It has proved to be the most satisfactory of the chemical treatments due to its effectiveness, low cost, and easy method of handling.

FORMALIN DISINFECTION

Formalin may be used for disinfection, but it is not to be preferred to heating, since the soil becomes too wet for planting and must be dried for a few days after the application. The soil to be disinfected should be first thoroughly prepared and placed in seed flats, and then drenched with a formalin solution composed of one part of commercial formalin (40 per cent formaldehyde) to 150 to 200 parts of water. To retain the fumes, the soil should be covered with cloth or banana leaves for from one to two days. The soil is then aired and dried for several days before sowing the seed.

FUNGICIDES

Certain diseases may be economically controlled by the application of fungicides. It is to be remembered that in the majority of cases the fungicides are applied as a preventive, to protect the plant against infection. Once a fungus has gained entrance to a plant tissue, the application of a fungicide will be of no avail. Fungi such as the powdery mildews and sooty molds, whose growth is superficial will be killed directly. Spraying must be done thoroughly, so that every part of the plant surface is covered with a film of the preparation. This can be accomplished only by the use of proper spraying apparatus which will produce a fine mist, and cover the plant without drenching. The standard Bordeaux mixture is the best general spray for use in the Philippine Islands. For special purposes other sprays may be used.

The cost of spraying citrus trees for canker including materials and labor is, for Bordeaux mixture, five centavos a tree, and for Burgundy mixture, seven centavos a tree. Lime-sulphur sprays can be applied at approximately six centavos a tree.

STANDARD BORDEAUX MIXTURE

MATERIALS

Copper sulphate (blue vitriol), kilograms..... 1.8
Stone lime, kilograms..... 1.8
Water, liters .....190.

The amount of copper sulphate may be varied according to the formula given. The weight of stone lime should be equal to or exceed the weight of copper sulphate. The important point to consider in regard to the materials is that good unslaked stone lime must be used. Bordeaux mixture cannot be prepared with air-slaked lime.

APPARATUS

Two half-barrels with a capacity of about 115 liters, made by sawing in two a 230 liter barrel.

One, 230-liter mixing barrel.
Two or more wooden pails.
One strong paddle, about 2 meters long.
One pair of hand scales.

PREPARATION

1. Dissolve 1.8 kilograms of copper sulphate in hot water; place in half barrel, and add water to make 95 liters.

2. Slake 1.8 kilograms of stone lime in the second half barrel and add water to make 95 liters.

3. Mix solutions, having two operators, each provided with a bucket. Dip up equal amounts of the copper sulphate and lime solutions and pour them together, at the same rate, at a height of 60 to 90 centimeters above a mixing barrel.

4. Mix the whole thoroughly by stirring vigorously.

5. Strain the mixture when putting it into the spray tank.

6. Apply to the plants with a good pressure spray pump. Use the mixture as soon as it is prepared.

If other than the above formula is given, take respective kilograms as indicated in the new formula. For example, to make a preparation containing 1.8 kilograms of copper sulphate, 2.25 kilograms of stone lime, to 190 liters of water, take 1.8 kilograms of copper sulphate and dissolve in 95 liters of water, slake 2.25 kilograms of stone lime, and add water to make 95 liters. Mix the two as indicated above.

The two solutions may be mixed by pouring the dilute solution of copper sulphate into a strong solution of lime and then thoroughly mixing the two and making them up to 190 liters.

BURGUNDY MIXTURE

This preparation may be used in place of the Bordeaux mixture, if it is impossible to obtain good stone lime. Burgundy mixture will not color the foliage and fruit to so great an extent as the Bordeaux mixture. The result obtained with this spray is about equal to that of Bordeaux mixture.

MATERIALS

Copper sulphate (blue vitriol), kilograms..... 1.4
Sodium carbonate (sal soda), kilograms 1.65
Water, liters.....190.

APPARATUS

The same apparatus as is used for Bordeaux mixture.

PREPARATION

1. Dissolve each chemical separately in 95 liters of water.
2. Mix by pouring the two solutions into a third container as in Bordeaux mixture.
3. Apply with a good pressure spray pump as soon as the solution is prepared.

RESIN SODA STICKER

In spraying during the rainy season, especially on plants with waxy-surface foliage, it is highly desirable to add a sticker to the spray mixtures.

MATERIALS

Resin, kilogram.....0.9
Sodium carbonate (sal soda), kilogram.....0.45
Water, liters.....3.8

APPARATUS

A kerosene tin or similar utensil for boiling the solution.
A paddle.
A pair of hand scales.

PREPARATION

1. Dissolve 0.45 of a kilogram of sal soda in 3.8 liters of water, and boil the solution.
2. Add 0.9 of a kilogram of powdered resin and continue boiling until all is dissolved and the liquid is a clear brown. Care should be taken that the mixture does not boil over. For medium adhesive add two liters of this sticker to190 liters of the spray.

SULPHUR

For the control of powdery mildews and other superficial fungi, flowers of sulphur, or sulphur flour, may be used to the best advantage. The sulphur is dusted on affected plants, preferably when the plants are wet with dew or rain.

LIME-SULPHUR SPRAY

In spraying operations it is often desirable to employ a spray that will control, to at least some extent, sucking insects and fungi at the same time. The lime-sulphur spray should be used under these circumstances although plants of very tender foliage will not stand a highly concentrated mixture.

MATERIALS

Stone lime, kilograms.....16.2
Flowers of sulphur, kilograms..... 36.
Water to make, liters.....190.

APPARATUS

An open kettle large enough to hold 190 liters.
A strong paddle
A pair of hand scales.
A cloth strainer.

PREPARATION

1. Slake the lime in a convenient amount of water, add the sifted sulphur, and stir vigorously during the process.

2. Make up to 190 liters with water.

3. Boil for one hour, adding water as necessary to prevent evaporation below 190 liters.

4. Stir from time to time.

5. Strain off the clear liquid into a tank, dilute and spray in the usual manner as given under Bordeaux mixture.

6. Storage. Concentrated lime-sulphur solutions keep well when stored in tight, filled, stoppered barrels, at the ordinary temperature. Paraffin or engine oil should be poured over the top of the solution.

The solution prepared in this manner is reddish brown and is too concentrated for direct application. The density of the concentrated solution must be determined before the spray can be used. A hydrometer, giving the readings in degrees Baumé, is the most common instrument used for this purpose. The standard on which dilutions are made is 32 degrees Baumé. Because of the varying strength of the preparation, dilutions must be made in the proportion of one liter of the concentrated solution, to from 10 to 30 liters of water. Table IV[19] shows the corresponding numbers of dilutions of lime-sulphur of different densities using 32 degrees Baumé as a standard.

TABLE IV.—*Dilutions for lime-sulphur spray.*

Concentrations.	Dilutions.			
	1 to 25	1 to 30	1 to 35	1 to 40
Degrees Baumé.				
20	14	17	20	23
21	15	18	21	24
22	16	19	22	25
23	16-½	20	23	26
24	17	21	24	27
25	18	22	25	29
26	19	23	26	30
27	20	24	28	32
28	21	25	29	34
29	22	26	30	35
30	23	27	32	36
31	24	28	33	38
32	25	30	35	40
33	26	31	36	41

[19] Stevens, H. E. Florida citrus diseases. University of Florida Agricultural Experiment Station Bulletin 150. August, 1918.

The first column represents concentrated solutions of different densities from 20 to 33 degrees Baumé. The headings of the succeeding columns show different dilutions that may be desired from the various concentrates, and the figures directly under represent the number of times the concentrate must be diluted to give the required dilution using 32 degrees Baumé as a standard.

Thus if a concentrated solution shows a Baumé reading of 29 degrees, and it is desired to use this in a dilution of 1 to 30 on the basis of 32 degrees as a standard, in the column under 1 to 30 opposite 29 degrees will be found the number 26. This indicates that 1 part of this concentrated solution should be diluted to 26 parts in order to obtain a spraying solution of a dilution of 1 to 30, or that 1 liter of the concentrated solution is added to 25 liters of water to give the desired solution.

The dilution suitable to use, varies with the plants to be sprayed and the season. The usual strengths to use on plants in foliage are the dilutions 1 to 30 or 1 to 35 on the basis of 32 degrees Baumé as a standard.

A commercially prepared lime-sulphur solution may be purchased. This solution should be used as directed. It is much more expensive than the home-boiled preparation.

SELF-BOILED LIME-SULPHUR SPRAY

Some tender-foliaged and young plants cannot stand the toxic effects of copper sprays or the concentrated lime-sulphur spray. For these cases the self-boiled lime-sulphur spray should be employed.

MATERIALS

Stone lime, kilograms	14.4
Flowers of sulphur, kilograms	14.4
Water to make, liters	760.

In this preparation four times the quantities given in the usual formula are used, because it has been found that these quantities give more satisfactory and convenient conditions for cooking than when smaller or greater amounts are used. If smaller amounts are desired, fractions of this formula may be used.

APPARATUS

One strong 190-liter barrel.
One strong paddle, about 2 meters long.
One sifter (flour sifter).
Two or more buckets.
One pair hand scales.
One strainer, of wire mesh.

PREPARATION

1. Weigh out 14.4 kilograms each of lime and sulphur, having first sifted the sulphur.
2. Place lime in barrel and add slowly about 15 liters of water.
3. Add sulphur as soon as the lime begins to slake actively.
4. Stir preparation vigorously with the paddle, adding enough water from time to time to avoid "burning," and still not enough to "drown" the lime.

5. Add at least 95 liters of cold water with vigorous stirring as soon as the lumps of lime are thoroughly slaked. It is very important to cool the preparation at this time by adding the water as indicated.

6. Make up to 760 liters in a spray tank, or dilute fractions of the stock solution correspondingly.

7. Strain before putting into the spray tank by running the solution through a wire mesh strainer. Any lumps of sulphur should be worked through with a small paddle.

8. Apply the spray with any good pressure spray pump.

FORMALIN SPRAY

This spray is used only for special purposes, such as spraying badly diseased citrus trees in order to defoliate them of all leaves attacked by citrus canker and to kill sucking insects. The solution of formalin should contain between 0.4 and 0.5 per cent of formaldehyde. This percentage of formalin may be used in combination with the standard Bordeaux mixture, using the latter mixture as a diluting agent.

SPRAYING APPARATUS

For spraying operations conducted on a small scale a bucket pump or a knapsack pump will serve. Bucket pumps cost from seven to ten pesos, and knapsack pumps, from twenty to forty pesos.

Where extensive spraying operations are undertaken it will be necessary to employ a good pressure barrel pump which will do the work more efficiently and in less time. The cost varies from forty-five to one hundred pesos, including hose and nozzle.

A good nozzle, which is essential in order to obtain the best results, will produce a fine mist and cover evenly the portion of the plant sprayed. There are many spraying outfits on the market, and in purchasing, one should be selected which is simple, with accessible parts; and one which will produce a good pressure and a fine, uniform mist of spray.

ANTISEPTICS AND WOUND COVERINGS

In the treatment of diseases such as bark rot, gummosis, and foot rot it is frequently necessary to remove portions of the bark and wood. Also during pruning operations cuts are left which afford a direct entrance for fungi. In order to prevent the ingress of fungi and bacteria, and in this way avoid decay and spread of disease, it is advisable to protect these with a wound covering until the new bark grows over. It is best to allow the cut surfaces to dry a day or so before the application of the antiseptics.

Under the discussion of the various diseases specific protective coverings were given as controls. The preparation of these remedies is given in the following list.

BICHLORIDE OF MERCURY (CORROSIVE SUBLIMATE)

Bichloride of mercury is a deadly poison to man and animals and should be so labeled. Plants treated with this solution must never be used for human food or be fed to animals.

Bichloride of mercury can be purchased in tablet form ready for use. A 1 to 1000 solution is commonly used. It is prepared by dissolving one tablet in one liter of water. If the corrosive sublimate crystals only can be obtained the preparation is as follows:

MATERIALS

Corrosive sublimate crystals, grams..... 112
Water, liters..... 114

PREPARATION

Dissolve the corrosive sublimate in from 2 to 4 liters of hot water, and dilute this strong solution with water to make 114 liters.

Bichloride of mercury should be used to disinfect pruning apparatus used in cutting out diseased parts of trees.

BORDEAUX PASTE

Bordeaux paste has been used with good success in the control of gummosis, bark rot, and foot rot of citrus. The diseased tissue should first be carefully removed with a knife and then the paste applied with a brush. It can also be applied to wounds on the trunk and branches of trees so as to avoid infection.

MATERIALS

Copper sulphate (blue vitriol), kilogram..... 0.5
Stone lime, kilogram..... 1.0
Water, liters..... 5.8

PREPARATION

Carefully slack the lime in 2.5 liters of water and allow it to cool. Dissolve the copper sulphate in 3.3 liters of water. Mix the two solutions by pouring the solution of copper sulphate into the lime and then stirring vigorously. Apply to the tree with a brush.

LIME AND SULPHUR PASTE

Lime and sulphur paste may be used in place of Bordeaux paste. It is not so effective as Bordeaux paste.

MATERIALS

Sulphur flour..... 1 part.
Lime, air-slaked..... 2 parts.

PREPARATION

Mix the sulphur and lime and then add water to make a thin paste. Apply with a brush.

LIME-SULPHUR SOLUTION. COMMERCIAL

Commercial lime-sulphur solution is used for spraying or painting the trunk and larger branches of diseased trees.

PREPARATION

Concentrated lime-sulphur, liters..... 4.0
Water, liters..... 36.0

The solution may be applied with a brush or a bucket spray pump. It should never be applied in this strength on foliage or tender plants.

CARBOLINEUM

Carbolineum is frequently used for the treatment of wounds and to control bark infections of fruit trees. Some preparations of carbolineum found on the market are extremely injurious to trees and these should be avoided. The solutions are commonly used half strength. The trunks and branches of young trees should never be painted as the carbolinuem will penetrate and kill the tree. It should be applied only to wounds. The carbolineum readily dissolves in a weak soap water. Application is by means of a brush.

COAL TAR

Coal tars may be used for painting over wounds so as to exclude the air and in this way prevent infection. Precaution must be exercised in its use because of the extreme caustic action of certain coal tars. The trunks of trees should never be coated. It should be applied only to wounds. Application is by means of a brush.

CRUDE CARBOLIC ACID

Crude carbolic acid is a strong disinfectant that can be used with success in the treatment of wounds. In such cases as with bark rot, the infected parts should first be cut out down to the healthy wood and then the carbolic acid applied, taking care that none of it runs down on the healthy tissue which would be burned.

The crude carbolic acid as purchased from drug stores should be diluted to half strength with water. It is preferable to use water in which a good laundry soap or whale oil soap has been dissolved at the rate of five hundred grams to four liters. The disinfectant is not permanent and must be applied from time to time until the wound is entirely healed.

FORMALIN

A diluted solution of formalin is used for disinfection of seeds, vegetative reproductive parts, and soil.

MATERIALS

Formalin (40 per cent formaldehyde), liter	0.5
Water, liters	150.

The above is the common formula for formalin. The amount of water varies with the purpose for which the solution is needed and with the length of treatment. Use as directed in special cases.

WHITE LEAD PAINT

White lead paint applied to wounds and cuts is an effective precaution to use against fungus infection. It is easily applied with a brush and adheres well.

SUMMARY

PHILIPPINES

DISEASES

Calamondin orange. *Citrus mitis* Blanco.

Diplodia. Bark rot, fruit rot, and gummosis.

Pseudomonas citri Hasse. Canker.

Citron. *Citrus medica* Linn.

Diplodia. Bark rot, fruit rot, and gummosis.

Meliola citricola Syd. Sooty mold.
Microcera coccophila Desm. On coccids.
Myriangium duriaei Mont. On coccids.
Pseudomonas citri Hasse. Canker.

Lemons, limes, mandarins, oranges, and pummelos. *Citrus* spp.
Albino.
Chlorosis. Non-parasitic.
Colletotrichum gloeosporioides Penzig. Wither tip.
Corticium salmonicolor B. et Br. Pink disease.
Cyathus montagnei Tul. On dead branches.
Die-back. Deficient nutrition.
Diplodia. Bark rot, fruit rot, and gummosis.
Duportella tristiuscula (Berk.) Pat. On dead branches.
Fomes applanatus Pers. On dead branches.
Foot rot.
Ganoderma australe (Fr.) Pat. On dead branches.
Gloeosporium intermedium Sacc. On injured leaves.
Greasy spot. On leaves.
Heterochaete tenuicula (Lév.) Pat. On dead branches.
Lichens. On trunk and branches.
Loranthus philippensis Cham. et Schlecht. Parasitic epiphyte.
Meliola citricola Syd. Sooty mold.
Microcera coccophila Desm. On coccids.
Mottled leaf. Non-parasitic.
Mucor. Black mold, fruit rot.
Myriangium duriaei Mont. On coccids.
Nummularia citrincola Rehm. On dead branches.
Ozonium auricornum Lk. On dead branches.
Penicillium. Fruit rot.
Phytophthora. Blight of seedlings.
Polyporus caryophylli Racib. On dead branches.
Polyporus hirsutus Fr. On dead branches.
Polystictus flavus Jungh. On dead branches.
Pseudomonas citri Hasse. Canker.
Rhizoctonia. Damping off.
Rhytidopeziza rufula (Spreng.) Bres. On dead branches.
Root rot. Undetermined.
Scaly bark. Undetermined.
Schizophyllum commune Fr. On dead branches.
Spiny mold. Imperfect fungus.
Splitting of fruit. Non-parasitic.
Sun scald. Non-parasitic.
Sclerotium. Damping off.
Septobasidium albidum Pat. On coccids on living branches.
Septobasidium reinkingii Pat. On coccids on living stems and leaves.

Lemon. *Citrus limonia* Osbeck.
Diplodia. Bark rot, fruit rot, and gummosis.
Pseudomonas citri Hasse. Canker.

Lime. *Citrus aurantifolia* (Christm.) Swingle.
Corticium salmonicolor B. et Br. Pink disease.
Diplodia. Bark rot, fruit rot, and gummosis.
Pseudomonas citri Hasse. Canker.

Lime. Native wild. *Citrus hystrix* DC.
Diplodia. Bark rot, fruit rot, and gummosis.
Pseudomonas citri Hasse. Canker.

Mandarin orange. *Citrus nobilis* Lour.
Corticium salmonicolor B. et Br. Pink disease.
Crinipellis galeatus (Berk. et Curt.) Pat. On dead branches.
Cystospora aberrans Sacc. On dead twigs.
Diaporthe citrincola Rehm. On dead branches.
Diplodia. Bark rot, fruit rot, and gummosis.
Diplodia aurantii Catt. On dead branches.
Eutypella citricola Speg. On dead branches.
Hypoxylon atropurpureum Fr. On dead branches.
Loranthus philippensis Cham. et Schlecht. Parasitic epiphyte.
Massarina raimundoi Rehm. On dead branches.
Meliola citricola Syd. Sooty mold.
Microcera coccophila Desm. On coccids.
Myriangium duriaei Mont. On coccids.
Phyllosticta circumsepta Sacc. On rind.
Pseudomonas citri Hasse. Canker.
Rhytidopeziza rufula (Spreng.) Bres. On dead branches.
Septobasidium albidum Pat.
Traversoa dothiorelloides Sacc. et Syd. On bark.
Tryblidiella mindanaensis P. Henn. On dead branches.
Tryblidiella rufula (Spreng.) Sacc. On dead branches.
Valsaria citri Rehm. On dead branches.
Xylaria castorea Berk. On living twigs.
Zignoella nobilis Rehm. On dead branches.

Orange. Common or sweet. *Citrus sinensis* Osbeck.
Diplodia. Bark rot, fruit rot, and gummosis.
Pseudomonas citri Hasse. Canker.

Orange. Sour or Seville. *Citrus aurantium* Linn.
Diplodia. Bark rot, fruit rot, and gummosis.
Pseudomonas citri Hasse. Canker.

Pummelo. *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck.)
Aschersonia sclerotioides P. Henn. On coccids.
Auricularia polytricha (Mont.) Sacc. On dead branches.
Colletotrichum gloeosporioides Penz. Wither tip.
Corticium salmonicolor B. et.Br. Pink disease.
Daldinia concentrica (Bolt.) Ces. et de Not. On dead branches.
Diplodia. Bark rot, fruit rot, and gummosis.
Duportella tristiuscula (Berk.) Pat. On dead twigs.
Eutypa heteracantha Sacc. On dead branches.
Eutypella citricola Speg. On dead branches.
Gloeosporium intermedium Sacc. On injured leaves.

Lichens. On trunk and branches.
Loranthus philippensis Cham. et Schlecht. Parasitic epiphyte.
Meliola citricola Syd. Sooty mold.
Mottled leaf. Non-parasitic.
Nectria episphaeria (Tode.) Fr. On *Eutypella citricola* Speg.
Penicillium. Fruit rot.
Phyllosticta circumsepta Sacc. On rind of fruit.
Polyporus rickii Pat. var. *philippinensis* Pat. On dead branches
Scaly bark. Undetermined.
Schizophyllum commune Fr. On dead branches.
Spiny mold. Imperfect fungus.

Satsuma or Unshiu orange. *Citrus nobilis* Lour. var. *unshiu* Swingle.
Diplodia. Bark rot, fruit rot, and gummosis.
Pseudomonas citri Hasse. Canker.

FUNGI PARASITIC ON SCALES

Aschersonia sclerotioides P. Henn. Yellowish, circular, and felty.
Microcera coccophila Desm. Red fungus.
Myriangium duriaei Mont. Black, felty fungus.
Septobasidium albidum Pat. Brown, leathery, and thick.
Septobasidium reinkingii Pat. Purplish, leathery, and thick.
Undetermined. Large, black, sclerotial body.

SCALE INSECTS

On fruit.[20]
Chrysomphalus (*Aonidiella*) aurantii (Mask.).
Lepidosaphes beckii (Newn.).
Lepidosaphes gloverii (Pack.).
Pseudaonidia trilobitiformis (Green).

On living leaves and twigs.[20]
Chrysomphalus aonidum (Linn.).
Chrysomphalus (*Aonidiella*) aurantii (Mask.).
Chrysomphalus dictyospermi (Morg.).
Coccus viridis (Green).
Lepidosaphes beckii (Newn.).
Lepidosaphes gloverii (Pack.).
Parlatoria brasiliensis n. sp. M. S.
Parlatoria pergandii Comst.
Parlatoria proteus (Curt.).
Parlatoria ziziphus (Lucas).
Pseudonidia trilobitiformis (*Green*).

SOUTHERN CHINA

DISEASES

Lemon. Sour red lemon. Ning Mung. *Citrus limonia* Osbeck.
Black spots. Undetermined. On branches and leaves.
Cladosporium citri Massee. Scab.

[20] Determinations by Harold Morrison, Bureau of Entomology, Washington, D. C.

Lichens. Undetermined. On trunk and branches.
Pseudomonas citri Hasse. Canker.

Lemon. Sweet red lemon. Tim Hung Ning Mung. *Citrus limonia* Osbeck.
Black spots. Undetermined. On branches and leaves.
Lichens. Undetermined. On trunk and branches.
Pseudomonas citri Hasse. Canker.

Lemon. White. Ning Mung. Paak Ning Mung. *Citrus limonia* Osbeck.
Black Spots. Undetermined. On branches and leaves.
Lichens. Undetermined. On trunk and branches.
Pseudomonas citri Hasse. Canker.
Septobasidium albidum Pat. On coccids.

Mandarin orange. Kat. *Citrus nobilis* Lour.
Algae. Undetermined. On leaves.
Aschersonia aleyrodis Webb. On coccids.
Black Spots. Undetermined. On branches and leaves.
Hypoxylon serpens (Pers.) Fr. On dead roots.
Lichens. Undetermined. On trunk and branches.
Meliola citricola Syd. Sooty mold.
Peroneutypa heterocantha Sacc. On dead branches.
Pseudomonas citri Hasse. Canker.
Witches broom. Undetermined.

Orange. Common or sweet. Chang. Lau Chang. *Citrus sinensis* Osbeck.
Aschersonia aleyrodis Webb. On coccids.
Black spot. Undetermined. On branches and leaves.
Cladosporium citri Massee. Scab.
Die back.
Diplodia. Bark rot.
Leaf spot. Undetermined.
Lichens. Undetermined. On trunk and branches.
Meliola citricola Syd. Sooty mold.
Mottled leaf. Physiological.
Pseudomonas citri Hasse. Canker.
Rosette. Non-parasitic.
Schizophyllum commune Fr. On dead trunk.
Septobasidium albidum Pat. On coccids.
Snails. Undetermined. On trunk and branches.
Yellowing. Non-parasitic.

Pummelo. Yau. Sha Tin Yau. *Citrus maxima* (Burm). Merr. (*Citrus grandis* Osbeck).
Algae. Undetermined. On branches and leaves.
Aschersonia aleyrodis Webb. On coccids.
Black spots. Undetermined. On branches and leaves.
Cladosporium citri Massee. Scab.
Diplodia. On dead leaves.
Eutypella citricola Speg. On dead branches.
Heterochaete tenuicula (Lév.) Pat. On dead branches.
Lichens. Undetermined. On trunk and branches.
Loranthus parasiticus (Linn.) Merr. Parasitic epiphyte. On branches.

Meliola citricola Syd. Sooty mold.
Phoma. On dead branches.
Pseudomonas citri Hasse. Canker.
Septobasidium carbonaceum Pat. On coccids.
Septobasidium leucostemum Pat. On coccids.
Tryblidiella rufula (Spreng.) Sacc. On dead branches.

Tangerine. Kom. *Citrus nobilis* Lour.
Aschersonia aleyrodis Webb. On coccids.
Black spots. Undetermined. On branches and leaves.
Cladosporium citri Massee. Scab.
Lichens. Undetermined. On trunk and branches.
Pseudomonas citri Hasse. Canker.
Rosette. Non-parasitic.
Septobasidium albidum Pat. On coccids.
Witches broom. Non-parasitic.

CITRUS RELATIVES

Severinia buxifolia Tenore.
Algae. Undetermined. On leaves.
Galls. Insect. On branches.
Meliola. Sooty mold.

Wampi. *Clausena lansium* Skeels.
Algae. Undetermined. On leaves.
Lichens. Undetermined. On trunk and branches.
Loranthus parasiticus (Linn.) Merr. Parasitic epiphyte. On branches.
Meliola. Sooty mold.

SCALE INSECTS

Orange. Common or sweet. Chang. Lau Chang. *Citrus sinensis* Osbeck.
Chrysomphalus ficus Ashm. (*aonidum* (Linn.)).
Icerya purchasi Mask. (?) (Determination from poor material)
Lepidosaphes beckii (Newn.).
Lepidosaphes gloverii (Pack.).
Parlatoria pergandii Comst.
Parlatoria zizyphus (Lucas).

Pummelo. Yau. Sha Tin Yau. *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck).
Lepidosaphes gloverii (Pack.).
Lepidosaphes beckii (Newm.).
Parlatoria pergandii Comst.
Pseudaonidia trilobitiformis (Green).

LEAF MINER

Citrus spp.
Phyllocnistis citrella Stainton.

WHITE FLY

Pummelo. Yau. Sha Tin Yau. *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck).
Aleurocanthus citriperdus Q. and B.

Kat. *Citrus nobilis* Lour.
Aleurocanthus citriperdus Q. and B.

INDO-CHINA

DISEASES

Citron. Thanh Yen. *Citrus medica* Linn.
Cladosporium herbarium (Pers.) Link. On dead branches and leaves.
Die back. Undetermined.
Diplodia. Bark rot and gummosis.
Pseudomonas citri Hasse. Canker.

Lemon. *Citrus limonia* Osbeck.
Algae. Undetermined. On branches and leaves.
Diplodia. Bark rot and gummosis.
Lichens. Undetermined. On trunk and branches.
Meliola citricola Syd. Sooty mold.
Phoma. Leaf blight.
Pseudomonas citri Hasse. Canker.
Tryblidiella rufula (Spreng.) Sacc. On dead branches.

Lime. Chanh Giay. Chanh Nuom. *Citrus aurantifolia* (Christm.) Swingle. (*Citrus acida* Roxb. *Citrus limonellus* Hassk.).
Algae. Undetermined. On branches and leaves.
Diplodia. Bark rot.
Lichens. Undetermined. On trunk and branches.
Meliola citricola Syd. Sooty mold.
Pseudomonas citri Hasse. Canker.

Mandarin orange. Cam Sanh. *Citrus nobilis* Lour.
Algae. Undetermined. On branches and leaves.
Meliola citricola Syd. Sooty mold.
Mottled leaf. Non-parasitic.
Phyllocnistis citrella Stainton. Leaf miner.
Pseudomonas citri Hasse. Canker.
Tryblidiella rufula (Spreng.) Sacc. On dead branches.

Pummelo. Cay Bu'o'i. *Citrus maxima.* (Burm.) Merr. (*Citrus grandis* Osbeck).
Algae. Undetermined. On trunk and branches.
Diplodia. Bark rot, fruit rot, and gummosis.
Heterochaete tenuicula (Lév.) Pat. On dead branches.
Leaf blight. Undetermined.
Lichens. Undetermined. On trunk and branches.
Meliola citricola Syd. Sooty mold.
Phyllocnistis citrella Stainton. Leaf miner.
Pseudomonas citri Hasse. Canker.
Tryblidiella rufula (Spreng.) Sacc. On dead branches.

SCALE INSECTS

Atalantia sp.
Aspidiotus cocotiphagus Marlatt.

Citrus spp.
Lepidosaphes beckii (Newm.).

Lepidosaphes gloverii (Pack.).
Parlatoria pergandii Comst.
Parlatoria ziziphus (Lucas.)
Lemon. *Citrus limonia* Osbeck.
Icerya sp. (?) (Material destroyed by enemies.)
Lime. Chanh Giay. Chanh Nuom. *Citrus aurantifolia* (Christm.) Swingle.
Parlatoria pergandii Comst.
Parlatoria ziziphus (Lucas).
Mandarin orange. Cam Sanh. *Citrus nobilis* Lour.
Fiorinia theae Green.
Pulvinaria sp.
Pummelo. Coy Bu'o'i. *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck).
Chrysomphalus aurantii (Mask.).
Coccus mangiferae (Green).
Lepidosaphes beckii (Newm.).
Lepidosaphes gloverii (Pack.).
Parlatoria ziziphus (Lucas).
Pseudaonidia trilobitiformis (Green).

SIAM

DISEASES

Citron. *Citrus medica* Linn.
Leaf blight. Undetermined.
Pseudomonas citri Hasse. Canker.
Lime. Small, Manow Klom. Large, Manow Yai. *Citrus aurantifolia* (Christm.) Swingle.
Algae. Undetermined. On branches and leaves.
Heterochaete tenuicula (Lév.) Pat. On dead branches.
Leaf spot. Undetermined.
Lichens. Undetermined. On trunks and branches.
Loranthus parasiticus (Linn.) Merr. Epiphytes. On branches.
Meliola citricola Syd. Sooty mold.
Pseudomonas citri Hasse. Canker.
Lime. Magrud. *Citrus hystrix* DC.
Algae. Undetermined. On leaves.
Galls. Undetermined. On trunk and branches.
Loranthus parasiticus (Linn.) Merr. Parasitic epiphyte. On branches.
Pseudomonas citri Hasse. Canker.
Mandarin orange. Som Keo Wan. *Citrus nobilis* Lour.
Pseudomonas citri Hasse. Canker.
Orange. Common or sweet. Som Kleang. *Citrus sinensis* Osbeck.
Colletotrichum gloeosporioides Penz. Russet of fruit.
Diplodia. Bark rot, fruit rot, and gummosis.
Greasy spot. Non-parasitic. On leaves.
Lichens and algae. Undetermined. On branches and leaves.
Loranthus parasiticus (Linn.) Merr. Parasitic epiphyte. On branches.
Meliola citricola Syd. Sooty mold.
Mottled leaf. Non-parasitic.

Pseudomonas citri Hasse. Canker.
Russet. Undetermined.
Septobasidium albidum Pat.

Pummelo. Som-o. *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck).
Algae. Undetermined. On branches and leaves.
Aschersonia aleyrodis Webb. On coccids.
Colletotrichum gloeosporioides Penz. Russet of fruit.
Diplodia. Bark rot, fruit rot, and gummosis.
Heterochaete tenuicula (Lév.) Pat. On dead branches.
Lichens. Undetermined. On trunk and branches.
Loranthus ferrugineus Roxb. Parasitic epiphyte. On branches.
Loranthus parasiticus (Linn.) Merr. Parasitic epiphyte. On branches.
Loranthus pentandrus Linn. Parasitic epiphyte. On branches.
Meliola citricola Syd. Sooty mold.
Mottled leaf. Non-parasitic.
Pseudomonas citri Hasse. Canker.
Russet. Undetermined.
Scaly bark. Undetermined.
Schizophyllum commune Fr. On dead branches.
Sclerotium. Fruit rot.
Septobasidium albidum Pat. On coccids.
Tryblidiella rufula (Spreng.) Sacc. On dead branches.
Witches broom. Non-parasitic.
Yellowing or chloratic condition. Non-parasitic.

Som-sa. *Citrus* species.
Pseudomonas citri Hasse. Canker.

Tangerine. *Citrus nobilis* Lour.
Algae. Undetermined. On leaves.
Loranthus parasiticus (Linn.) Merr. Parasitic epiphyte. On branches.

INSECTS

Dolichoderus sp. Ant. Mod dam. Tends aphids and scales.
Flea beetle. On leaves.
Oecaphylla smaragdina Fabr. Red tree ant. Mod dang. On branches.
Pheidologeton sp. Ant. Mod kan fie. On roots, trunks, branches, leaves, and fruits.
Phyllocnistis citrella Stainton. Leaf miner.
Termes sp. Termites. Pluag. On roots.

SCALE INSECTS[21]

Citron. *Citrus medica* Linn.
Lepidosaphes gloverii (Pack.).
Parlatoria ziziphus (Lucas).

Orange. Common or sweet. Som Kleang. *Citrus sinensis* Osbeck.
Lepidosaphes gloverii (Pack.).
Parlatoria pergandii Comst.
Parlatoria ziziphus (Lucas).

[21] Determinations by Harold Morrison, Bureau of Entomology, Washington, D. C.

Pummelo. Som-o. *Citrus maxima* (Burm.) Merr. (*Citrus grandis* Osbeck).
Chrysomphalus aonidum (Linn.).
Chrysomphalus aurantii (Mask.).
Coccus hesperidum (Linn.).
Lepidosaphes gloverii (Pack.).
Parlatoria brasiliensis n. sp. Ms.
Parlatoria ziziphus (Lucas).
Pseudaonidia trilobitiformis (Green).
Saissetia sp.
Tangerine. *Citrus nobilis* Lour.
Parlatoria ziziphus (Luxas).

ILLUSTRATIONS

Plate I

Severe attack of bark rot on the trunk of a mandarin orange, *Citrus nobilis* Lour. (From the *Philippine Agricultural Review*.)

Plate II

Fig. 1.—Bark rot of citrus produced by inoculation with a pure culture of *Diplodia* isolated from bark rot of Batangas mandarin, *Citrus nobilis* Lour. Decayed bark removed to show advance of disease.

2.—Bark rot of citrus produced by inoculation with a pure culture of *Diplodia* isolated from bark rot of Batangas mandarin, *Citrus nobilis* Lour. Same branch as Fig. 1, but with depressed and cracked bark not removed.

3.—Severe gummosis of citrus, preceding bark rot, produced by inoculation with a pure culture of *Diplodia* isolated from bark rot of Batangas mandarin, *Citrus nobilis* Lour.

4.—Branch of citrus used as control in bark rot inoculation experiments. Control was injured, but showed no infection.

5.—Bark rot of citrus produced by inoculation with a pure culture of *Diplodia* isolated from bark rot of Batangas mandarin, *Citrus nobilis* Lour. Decayed bark removed to show advance of disease.

6.—Bark rot of citrus produced by inoculation with a pure culture of *Diplodia* isolated from bark rot of Batangas mandarin, *Citrus nobilis* Lour. Same branch as Fig. 5, but with depressed and cracked bark not removed.

Plate III

Fig. 1.—Pure culture of *Diplodia* on corn meal plate, isolated from bark rot of Batangas mandarin, *Citrus nobilis* Lour.

2.—Black rot of citron, *Citrus medica* Linn., produced by *Diplodia*.

Plate IV

Fig. 1.—*Citrus nobilis* Lour. inoculated with a pure culture of *Diplodia* isolated from a rotted sweet potato, *Ipomoea batatas* (Linn.) Poir.

2.—*Citrus nobilis* Lour. inoculated with a pure culture of *Diplodia* isolated from a dried petiole of papaya, *Carica papaya* Linn.

3.—*Citrus nobilis* Lour. inoculated with a pure culture of *Diplodia* isolated from an ear of corn, *Zea mays* Linn.

4.—*Citrus nobilis* Lour. inoculated with a pure culture of *Diplodia* isolated from bark rot of Batangas mandarin, *Citrus nobilis* Lour.

5.—*Citrus nobilis* Lour. inoculated with a pure culture of *Diplodia phaseolina* Sacc. isolated from a dried pod of a bean, *Phaseolus lunatus* Linn.

Plate V

Fig. 1.—Seedling blight of citrus produced by inoculation with a pure culture of *Phytophthora* isolated from the blight of pummelo seedlings, *Citrus maxima* (Burm.) Merr.

2.—Blight of pummelo seedlings, *Citrus maxima* (Burm.) Merr., caused by a *Phytophthora*.
3.—Blight of shoots of budded pummelos, *Citrus maxima* (Burm.) Merr., caused by a *Phytophthora*.

PLATE VI

Fig. 1.—Mottled leaf of citrus.
2.—Citrus canker on leaves of citrus.
3.—Citrus canker on leaves of *Citrus maxima* (Burm.) Merr., showing spread of the disease by the leaf miner, *Phyllocnistis citrella* Stainton. (From *Philippine Journal of Science.*)

PLATE VII

Fig. 1.—Citrus canker on stem.
2.—Citrus canker on fruit and stem.
3.—Citrus canker on fruit of *Citrus maxima* (Burm.) Merr. (From *Philippine Journal of Science.*)

PLATE VIII

Fig. 1.—Natural infection of citrus canker produced on pummelo leaf, *Citrus maxima* (Burm.) Merr., through spine injury.
2.—Stomatal infection on leaves of a citrus hybrid produced by inoculation with a pure culture of *Pseudomonas citri* Hasse.
3.—Infection through needle pricks on the leaves of a citrus hybrid produced by inoculation with a pure culture of *Pseudomonas citri* Hasse.
4.—Stomatal infection on leaf of a citrus hybrid produced by inoculation with a pure culture of *Pseudomonas citri* Hasse.

PLATE IX

Fig. 1.—Longitudinal section through a branch of a Batangas mandarin, *Citrus nobilis* Lour., showing invasion of the parasitic epiphyte, *Loranthus philippensis* Cham. The *Loranthus* is darker in color than the citrus.
2.—Severe attack of *Loranthus parasiticus* (Linn.) Merr. on citrus from Siam.
3.—Severe attack of *Loranthus pentandrus* Linn. on seedless pummelo of Siam, *Citrus maxima* (Burm.) Merr. The large knob-like structures are of the *Loranthus*.

PLATE X

Fig. 1.—Pink disease on branch of *Allamanda cathartica* Linn. caused by *Corticium salmonicolor* Berk. et Br.
2.—Pink disease on branch of *Artocarpus integra* (Thunb.) Merr., caused by *Corticium salmonicolor* Berk. et Br.
3.—Pink disease on branch of *Annona muricata* Linn. caused by *Corticium salmonicolor* Berk. et Br.
4.—Pink disease on branch of citrus, *Citrus nobilis* Lour., caused by *Corticium salmonicolor* Berk. et Br.
5.—Pink disease on branch of citrus, *Citrus nobilis* Lour., caused by *Corticium salmonicolor* Berk. et Br.
6.—Pink disease on branch of *Annona squamosa* Linn., caused by *Corticium salmonicolor* Berk. et Br.
7.—Pink disease on branch of citrus, *Citrus nobilis* Lour., caused by *Corticium salmonicolor* Berk. et Br.

PLATE XI

Fig. 1.—*Microcera coccophila* Desm., pink fungus, characterized by outgrowths and fringes of fungus tissue, on citrus scale insects. The black, felty masses are of the fungus *Myriangium duriaei* Mont., also parasitic on citrus scale insects.
2.—*Septobasidium reinkingii* Pat., purplish, leathery, and smooth fungus covering leaves and branches of a citrus hybrid. The fungus starts as a parasite on citrus scale insects.
3.—*Microcera coccophila* Desm., pink fungus characterized in the photograph by the whitish appearing fringe about the scale on the fruit; and *Myriangium duriaei* Mont., black, felty fungus, characterized in the photograph by the blackish masses on the fruit.

PLATE XII

Fig. 1.—Severe lichen attack on orange, *Citrus sinensis* Osbeck.
2.—Citrus canker on leaf of orange, *Citrus sinensis* Osbeck.

3.—Citrus canker on stem of pummelo, *Citrus maxima* (Burm.) Merr.

4.—Citrus canker on leaf of pummelo, *Citrus maxima* (Burm.) Merr.

5.—Severe *Septobasidium albidum* Pat. attack on living twigs of sour red lemon, *Citrus limonia* Osbeck. The fungus is parasitic on coccids.

6.—*Septobasidium albidum* Pat. on twigs of orange, *Citrus sinensis* Osbeck. The fungus is parasitic on coccids.

PLATE XIII

Fig. 1.—Leaves of parasitic epiphyte, *Loranthus parasiticus* (Linn.) Merr.

2.—Parasitic epiphyte, *Loranthus parasiticus* (Linn.) Merr. above, and pummelo, *Citrus maxima* (Burm.) Merr., below. Note the root-like structures that penetrate the citrus.

3.—Work of the flea beetle, and the leaf miner, *Phyllocnistis citrella* Stainton, on leaves of orange, *Citrus sinensis* Osbeck.

4.—Citrus canker on leaf of orange, *Citrus sinensis* Osbeck.

5.—*Aschersonia aleyrodis* Webb. on orange leaf, *Citrus sinensis* Osbeck. Parasitic on coccids.

6.—Scab on leaves of tangerine, *Citrus nobilis* Lour.

PLATE XIV

Fig. 1.—Black, spherical, sclerotial bodies of an undetermined fungus parasitic on citrus scale insects on branch of *Citrus nobilis* Lour.

2.—Winding galleries of the common leaf miner, *Phyllocnistis citrella* Stainton, on leaves of the Siam seedless pummelo, *Citrus maxima* (Burm.) Merr.

3.—Severe gall formation on branches of the Siam lime, or magrud, *Citrus hystrix* DC. Citrus canker caused by *Pseudomonas citri* Hasse present on the leaf.

PLATE I. SEVERE ATTACK OF BARK ROT ON THE TRUNK OF A MANDARIN ORANGE (*CITRUS NOBILIS* LOUR.).

PLATE II. BARK ROT AND GUMMOSIS OF CITRUS PRODUCED BY INOCULATION WITH A PURE CULTURE OF *DIPLODIA*.

1

2

PLATE III. PURE CULTURE OF *DIPLODIA* GROWING ON CORN MEAL.
BLACK ROT OF CITRON PRODUCED BY *DIPLODIA*.

PLATE IV. GUMMOSIS AND BARK ROT OF CITRUS PRODUCED BY INOCULATION WITH VARIOUS FORMS OF *DIPLODIA* ISOLATED FROM DIFFERENT HOSTS.

PLATE V. BLIGHT OF CITRUS SEEDLINGS AND SHOOTS FROM BUDDED CITRUS PRODUCED BY A *PHYTOPHTHORA*.

PLATE VI. MOTTLED LEAF AND CANKER OF CITRUS. CANKER ORGANISM SPREAD BY A LEAF-MINING INSECT.

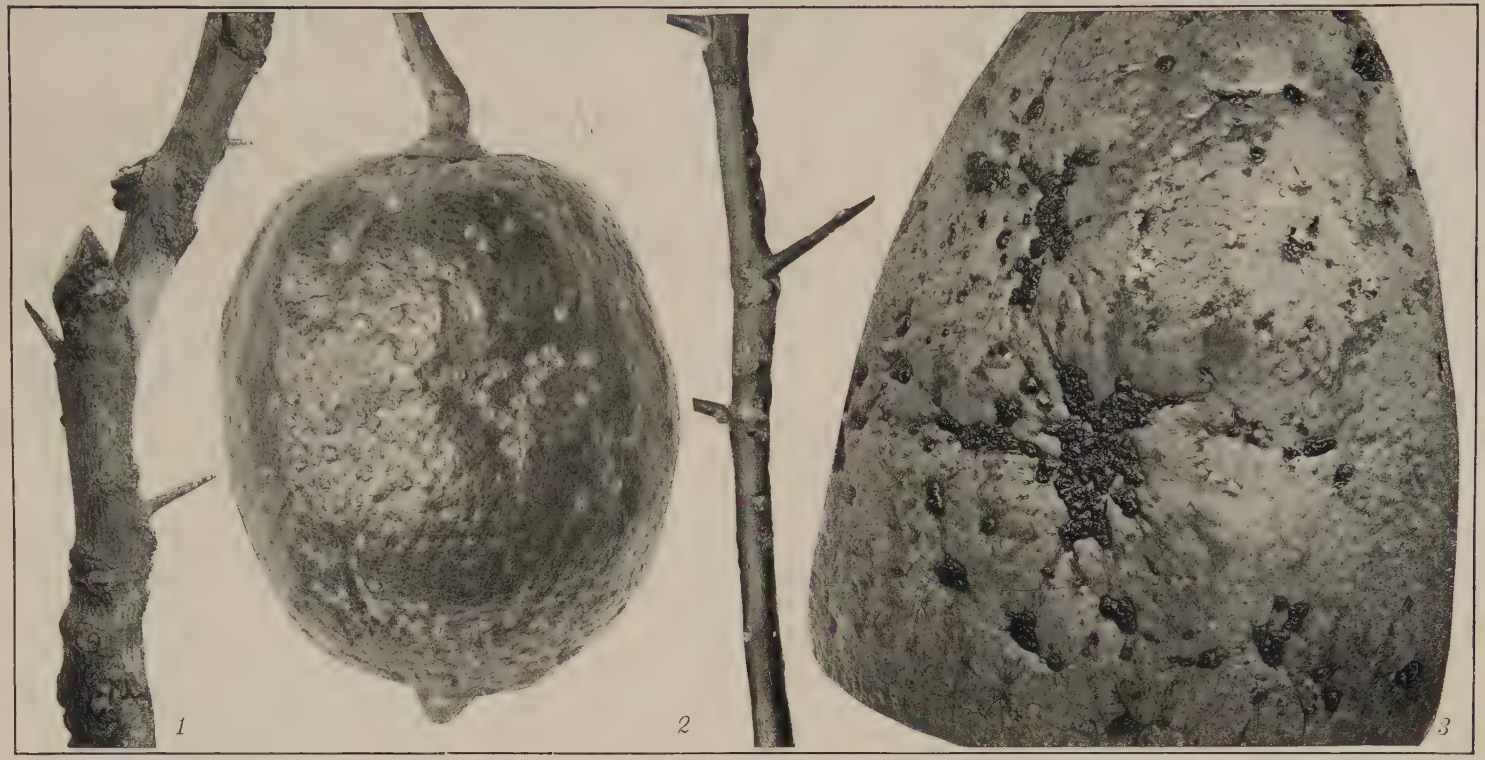

PLATE VII. CITRUS CANKER ON BRANCHES AND FRUIT.

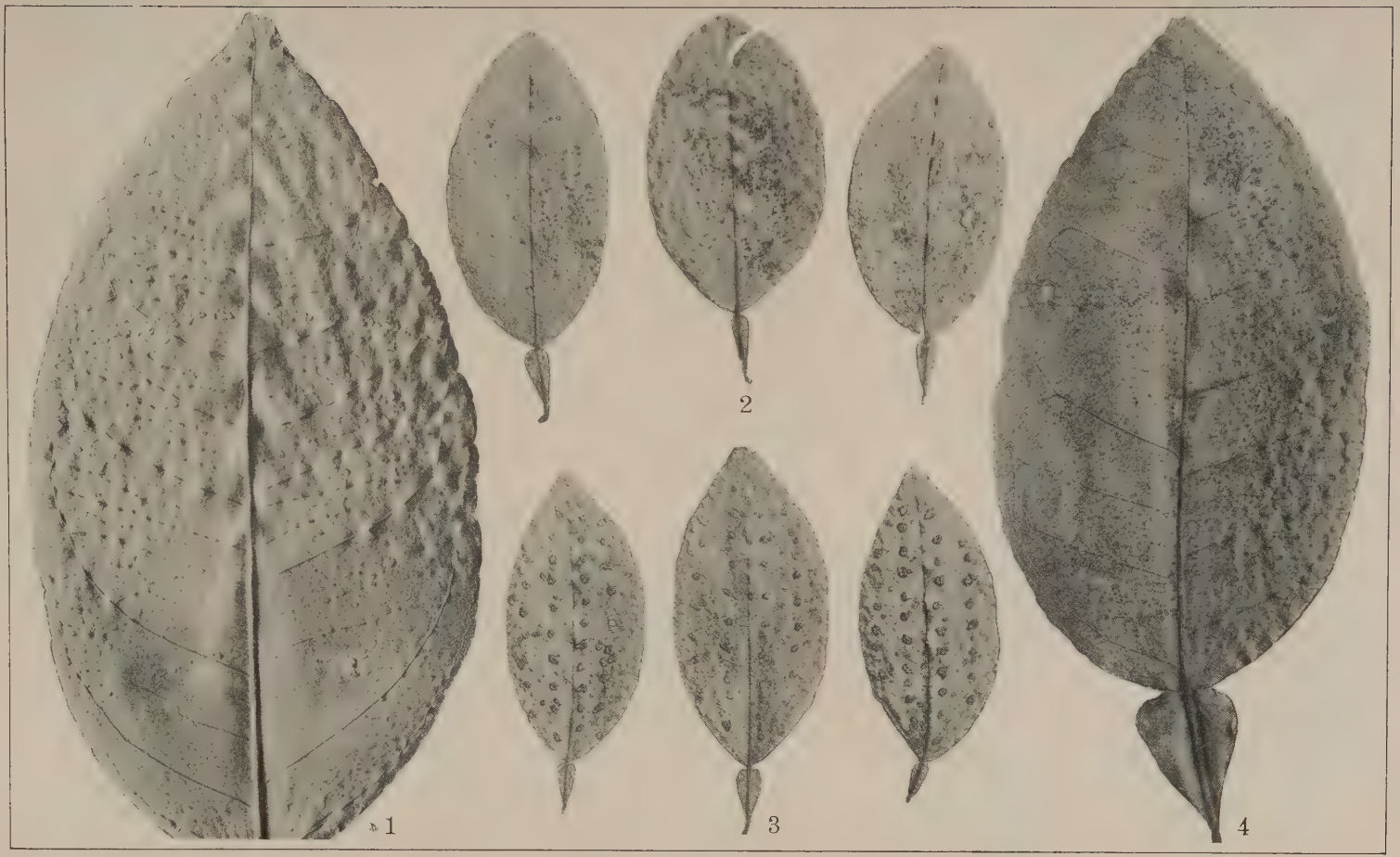

PLATE VIII. CITRUS CANKER INFECTION THROUGH INJURIES AND STOMATA.

PLATE IX. *LORANTHUS*, PARASITIC EPIPHYTE ON CITRUS BRANCHES.

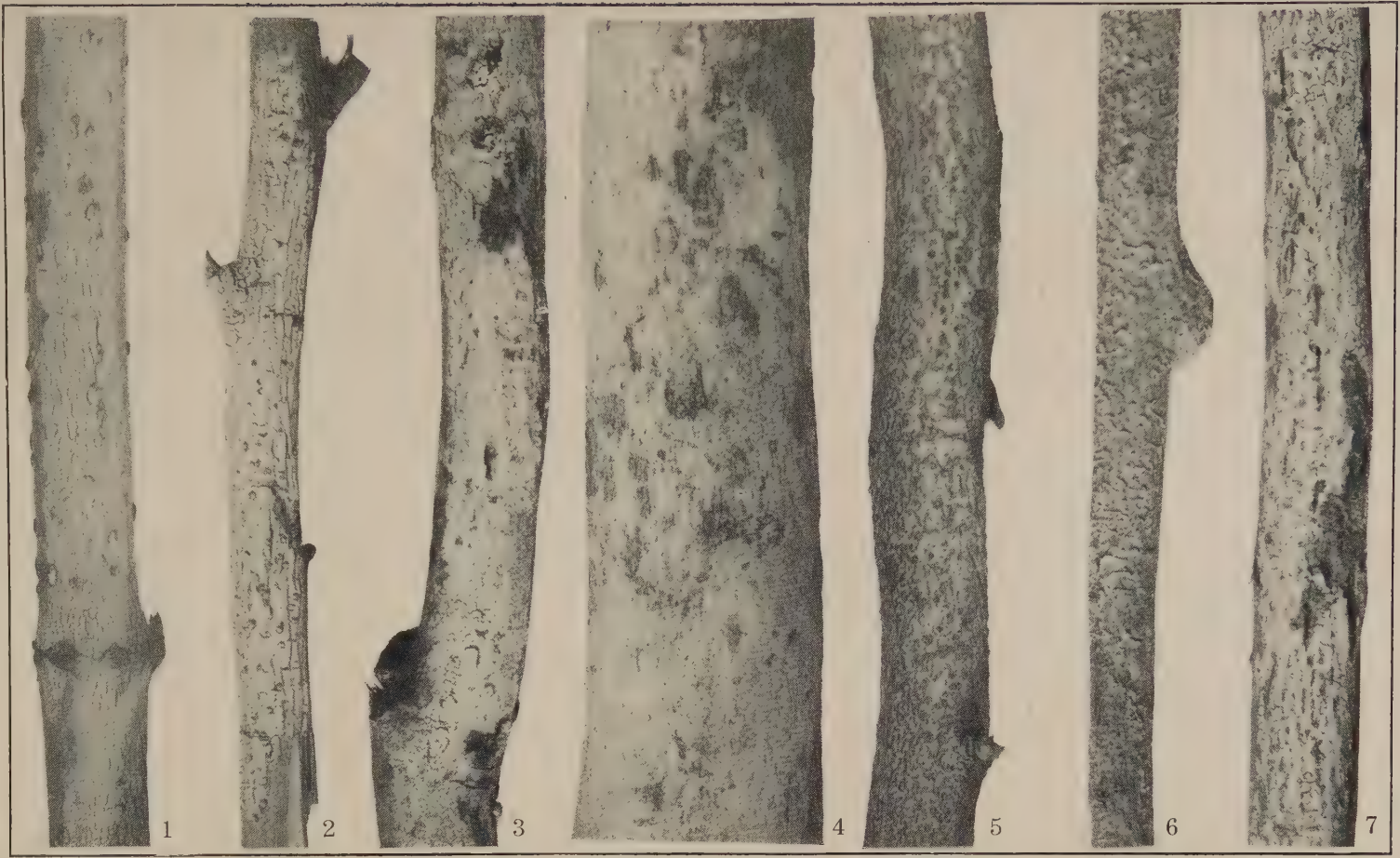

PLATE X. PINK DISEASE OF CITRUS AND OTHER HOSTS.

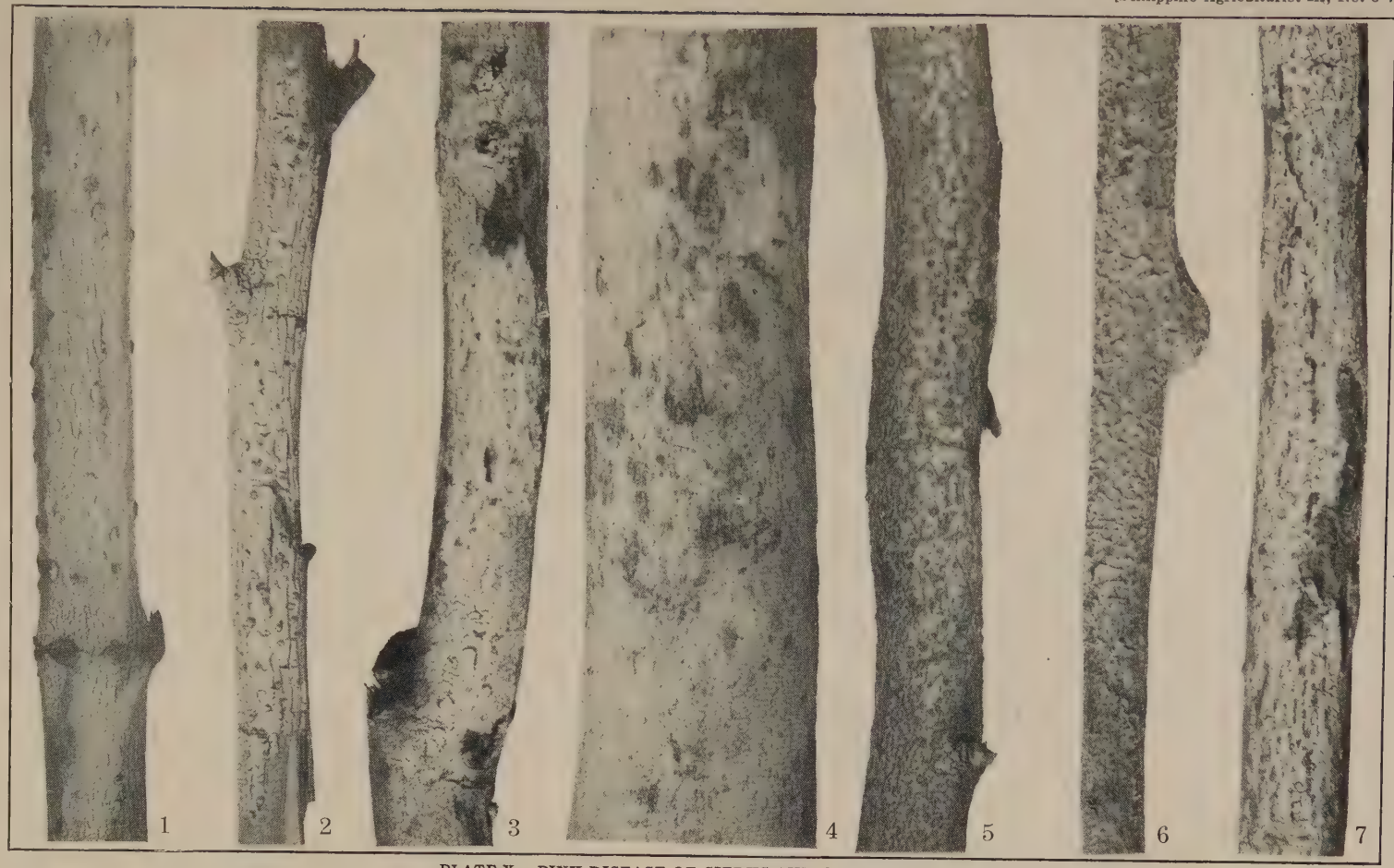

PLATE X. PINK DISEASE OF CITRUS AND OTHER HOSTS.

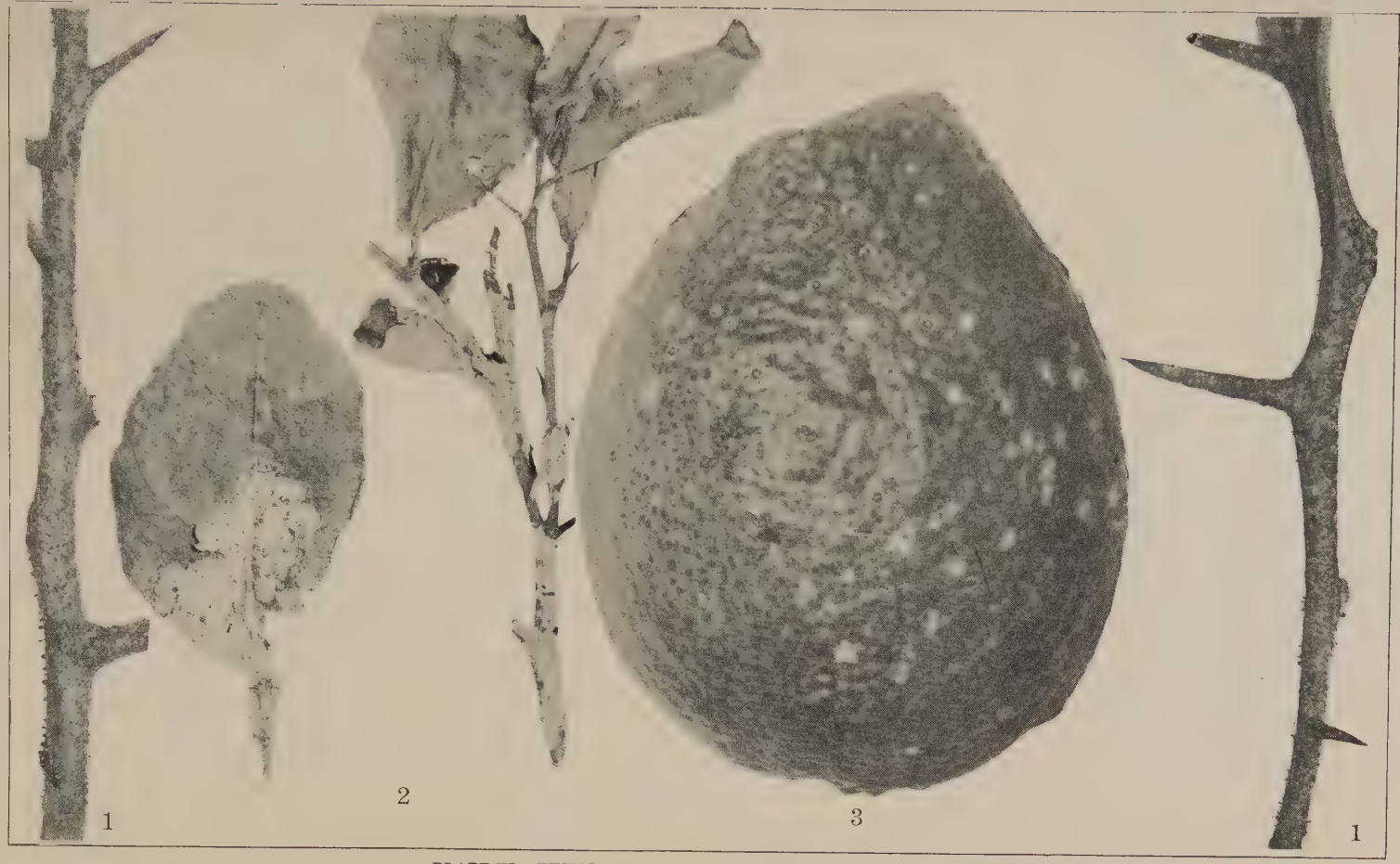

PLATE XI. FUNGI PARASITIC ON CITRUS SCALE INSECTS.

PLATE XII. DISEASES OF CITRUS FROM SOUTHERN CHINA.

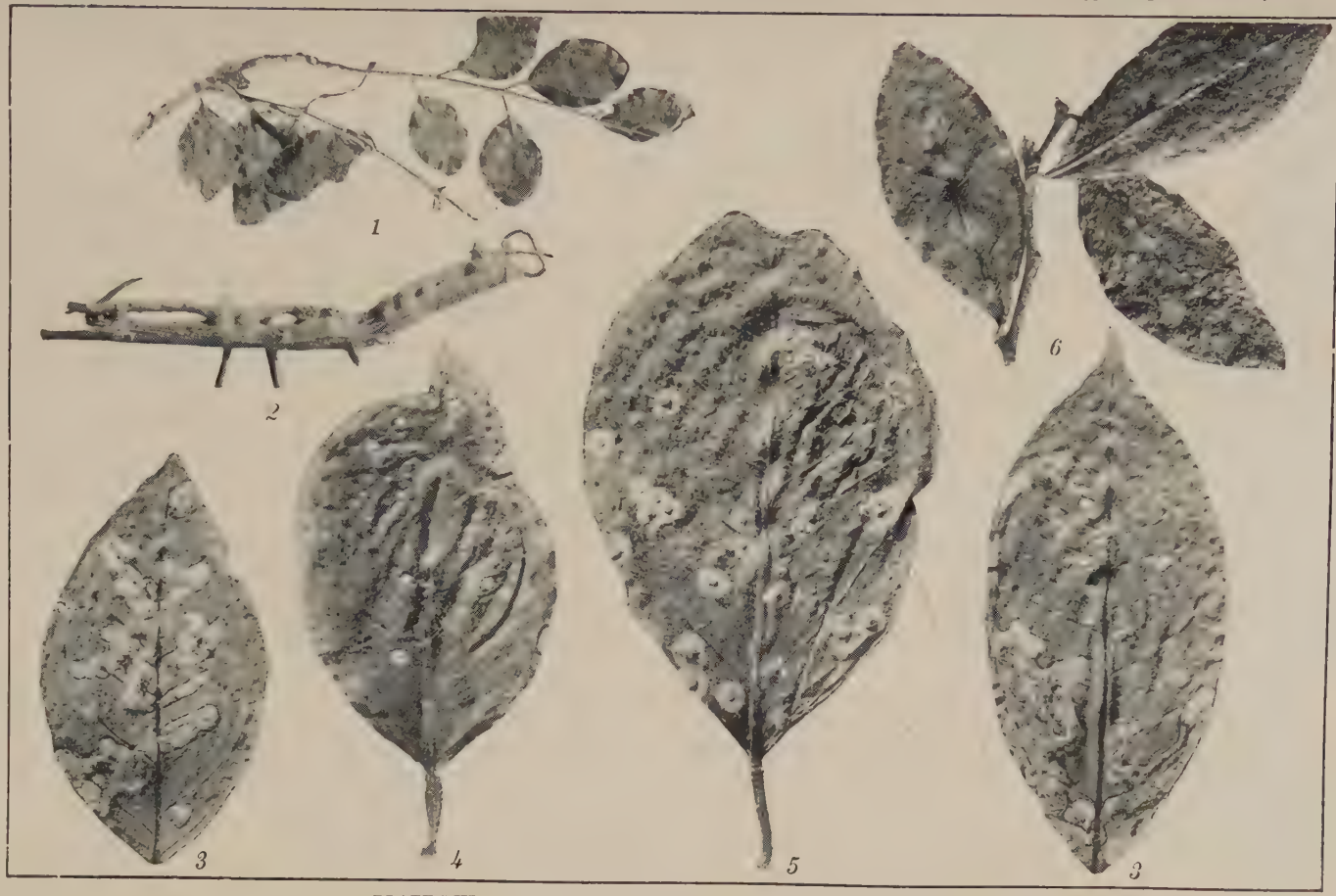

PLATE XIII. DISEASES OF CITRUS FROM SOUTHERN CHINA.

PLATE XIV. FUNGUS PARASITIC ON CITRUS SCALE INSECTS. CITRUS OF SIAM ATTACKED BY LEAF MINER AND GALL PRODUCING ORGANISM.

NOTES ON DISEASES OF ECONOMIC PLANTS IN INDO-CHINA AND SIAM[1]

By Otto A. Reinking

Professor of Plant Pathology
and Plant Pathologist of the Agricultural Experiment Station, Los Baños, Philippine Islands.

The list of fungi on economic plants given below was prepared by the writer from his collections made in June and July, 1920, during an investigation of citrus diseases. An account of the diseases of citrus in Indo-China and Siam is not included as it appears in a separate article in this journal. The diseases here given undoubtedly comprise only a part of the fungi attacking plants, as the investigation was made during the extreme dry season. Enough destructive fungi, however, were found to give some idea of their prevalence.

INDO-CHINA

Areca catechu Linn. Betel palm.

Pestalozzia palmarum Cke. et Grev. On weakened leaves.

Bambusa spp. Bamboo.

Puccinia longicornis Pat. et Hor. Rust. Severe.

Caryota ochlandra Hance. Fish tail palm.

Pestalozzia palmarum Cke. et Grev. On dead leaves.

Cocos nucifera Linn. Coconut.

Pestalozzia palmarum Cke. et Grev. Leaf spot. Medium severe.

Coffea arabica Linn.

Hemileia vastatrix B. et Br. Rust. Severe.

Coffea liberica Hiern.

Algae.

Black mold.

Dictyothyriella mucosa Syd. (*Micropeltis mucosa* Syd.). Leaf speck.

Fruit rot.

Euphoria longana Lam. (*Nephelium longana*) Camb. Longan.

Black mold on leaf.

Lichens on leaf.

Ficus carica Linn. Fig.

Uredo fici Cast. Rust. Medium severe.

Ficus sycomorus Linn. Fig.

Uredo fici Cast. Rust. Medium severe.

Gossypium spp. Cotton.

Mycosphaerella gossypina (Cke.) Atk. (*Cercospora gossypina* Cke.) Leaf spot.

Ipomea batatas (Linn.) Poir. Sweet potato.

Cercospora batatae Zimm. Leaf spot. Severe.

Luffa cylindrica M. Roem. Patola.

Pseudoperonospora cubensis (B. et C.) Rost. Downy mildew.

---

[1] University of the Philippines, College of Agriculture Experiment Station contribution No. 45.

Mangifera indica Linn. Mango.
Algal leaf spot (green). Severe.
Leaf blight.
Manihot utilissima Pohl. Cassava.
Cercospora henningsii Allesch. Leaf spot. Not severe.
Musa sapientum Linn. Banana.
Macrophoma musae (Cke.) Berl. et Vogl. Leaf spot. Severe on old leaves.
Nicotiana tabacum Linn. Tobacco
Cercospora nicotianae Ell. et Ev. Leaf spot. Medium severe.
Persea americana Mill. (*Persea gratissima* Gaertn.) Avocado.
Algal leaf spot (green). Severe.
Piper nigrum Linn. Black pepper.
Algal leaf spot (green). Not severe.
Leaf blight. Not severe.
Mottled leaf or chlorotic condition.
Ricinus communis Linn. Castor oil plant.
Cercosporina ricinella (Sacc. et Berl.) Speg. Leaf spot. Medium severe.
Saccharum officinarum Linn. Sugar cane.
Cercospora vaginae Kr. Leaf sheath spot. Severe on old cane.
Saccharum spontaneum Linn. Wild sugar cane.
Sclerospora. Leaf shredding. Severe and widespread.

SIAM

Achras sapota Linn. Chico.
Algal leaf spot (green). Severe.
Cocos nucifera Linn. Coconut.
Pestalozzia palmarum Cke. et Grev. Leaf spot. Medium severe.
Trunk rot.
Euphoria longana Lam. (*Nephelium longana* Camb.). Longan.
Algal leaf spot. Severe.
Insect leaf galls. Severe.
Luffa cylindrica M. Roem. Patola.
Pseudoperonospora cubensis (B. et C.) Rost. Downy mildew.
Mangifera indica Linn. Mango.
Algae.
Insect leaf galls.
Meliola mangifera Earle. Black mold.
Manihot utilissima Pohl. Cassava.
Cercospora henningsii Allesch. Leaf spot.
Musa sapientum Linn. Banana.
Black mold on leaves.
Macrophoma musae (Cke.) Berl. et Vogl. Leaf spot.
Psidium guajava Linn. Guava.
Aithaloderma clavatisporum Syd. Black mold.
Algal leaf spot (green).
Rosa spp. Rose.
Black mold.
Scales. Severe.

Saccharum officinarum Linn. Sugar cane.

Cercospora vaginae Kr. Leaf sheath spot.

Sclerotium. On dead stem.

Sclerospora. Leaf shredding.

The determination was made from observation under field conditions. No specimens could be collected which made it impossible to examine under the microscope. A *Sclerospora* is, however, widely found on the wild cane, *Saccharum spontaneum* Linn.

Melanconium sacchari Massee. Rind disease. Severe on dead culms.

Saccharum spontaneum Linn. Wild sugar cane.

Sclerospora. Leaf shredding. Severe.

Theobroma cacao Linn. Cacao.

Phytophthora faberi Maubl. Black rot of pods. Severe.

NOTES ON COCCIDS AND ALEYRODES ON VARIOUS HOSTS IN INDO-CHINA AND SIAM[1]

By Otto A. Reinking

Professor of Plant Pathology
and Plant Pathologist of the Agricultural Experiment Station, Los Baños, Philippine Islands

The coccids and aleyrodes listed below were obtained by the writer on a trip made in June and July, 1920, during an investigation of citrus diseases. They are only miscellaneous collections made of those forms that were abundant at that time of the year. The list does not purport to represent all of these insects that may be present in the two countries.

BEN CAT, INDO-CHINA

Coffea liberica Hiern. Coffee.
Coccus viridis (Green). On leaves.

KEP, CAMBODIA, INDO-CHINA

Piper nigrum Linn. Black pepper.
Chrysomphalus aurantii (Mask.).
Lepidosaphes beckii (Newm.).
Paralecanium expansum, var. *quadratum* (Green) (?).
Phenacaspis eugeniae (Mask.) (?).

SAIGON, INDO-CHINA

Mangifera indica Linn. Mango.
Paralecanium expansum, var. *quadratum* (Green) (?). On leaves.

TOLUNGMUK, INDO-CHINA

Gardinia sp.
Coccus sp. On leaf.

CHIENG MAI, SIAM

Hibiscus sp.
Saissetia nigra (Nietn.)
Ricinus communis Linn.
Trialeourodes sp. [2]

---

[1] University of the Philippines, College of Agriculture Experiment Station contribution No. 46.

[2] Determintion by A. C. Baker, Bureau of Entomology, Washington, D. C. All other determinations in this article are by Harold Morrison, Bureau of Entomology, Washington, D. C.